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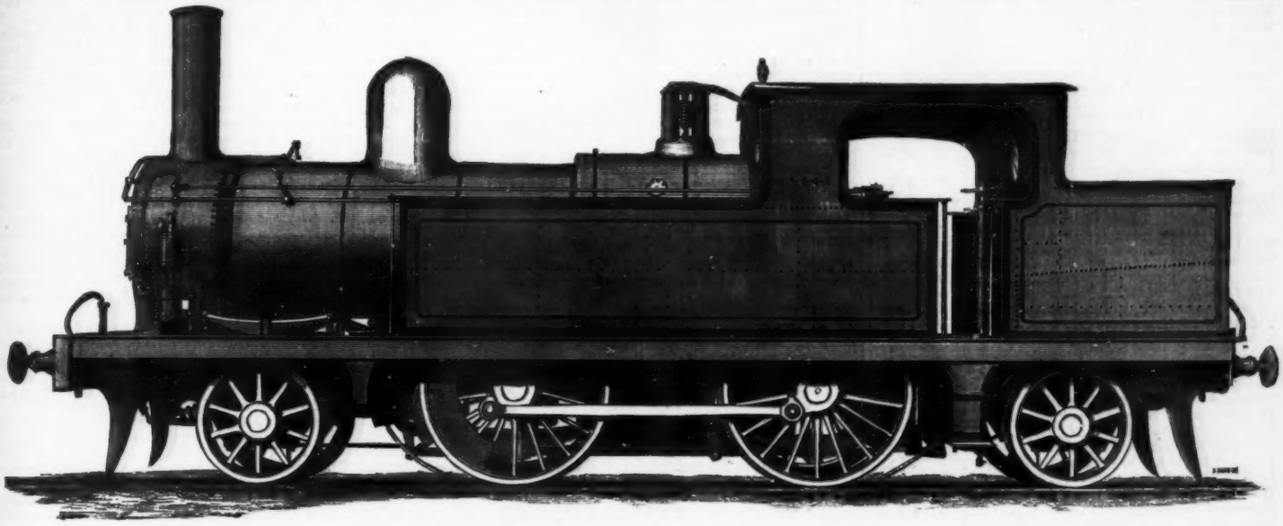


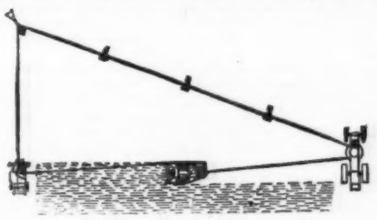
TANK LOCOMOTIVE.—RHENISH RAILWAY.

STEAM PLOWING ENGINE.

At the recent show of the Royal Agricultural Society at Derby, John Fowler & Co., of Leeds, exhibited at an adjacent trial field a new arrangement of eight horse double-drum plowing engine. Of this engine we now give a perspective view. It is of the type suitable for use in connection with a traveling anchor, the mode of working being explained by the diagram which we annex.

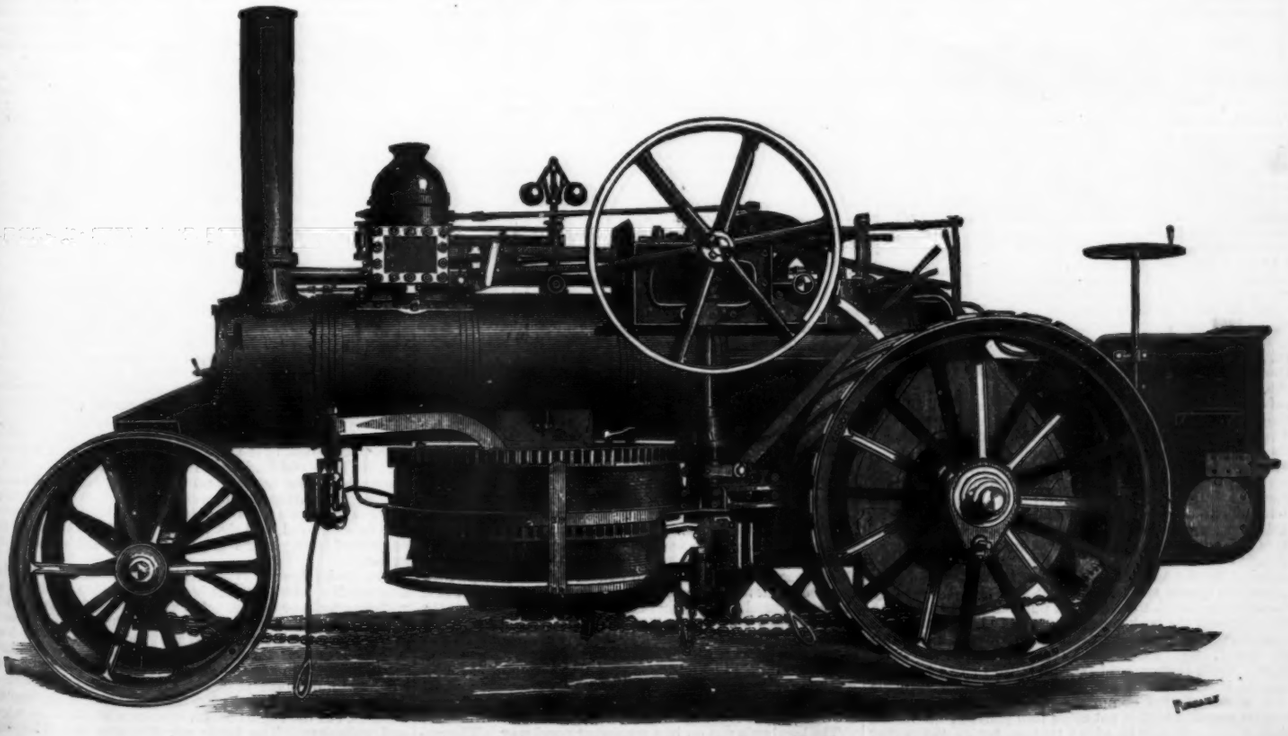
The two drums are placed one over the other, the direction in which the ropes are coiled being such that in the case of the lower drum the strain due to the pull on the rope comes for the most part directly on the teeth of the driving pinion, the center stud on which the drum revolves being thus proportionately relieved of strain. Each of the drums is provided with coiling gear, so that the ropes are coiled correctly.

The leading wheels are placed comparatively close together, so that the ropes can be led off in any direction through a very considerable angle. The driving wheels are 6 ft. 6 in. in diameter. All the cast brackets, gear, etc., of the engine are of steel, while the drums are built up of steel plates to insure strength and lightness. The arrangement of the drums, of course, causes the boiler to stand higher than usual, but the height is not in any way objectionable, and the whole arrangement is a decided improvement on that of the former double drum engines.—*Engineering.*



TANK LOCOMOTIVE, DUTCH RHENISH RAILWAY.

We illustrate, from *The Engineer*, a tank engine for passenger service, built by Messrs. Sharp, Stewart, and Company, Limited, of Manchester, for the Dutch Rhenish Railway Company. The engine is, as will be seen, of the "double-ender" type, with inside cylinders, four coupled wheels, and a pair of running wheels at either end. These are fitted with radial axle-boxes, on an arrangement designed by the makers, which insures the perfect contact of the sliding surfaces in all positions of the wheels, allowance being made for the vertical inequalities of the rails, as well as for the lateral curvature, all risk of the jamming of the slides when one wheel is raised higher than the other being thus avoided. The lateral movement of these boxes when on a curve is controlled by means of spiral springs set in their places with considerable initial compression, so that the wheels are held much more stiffly in the central position when the engine is running on a straight road than is usually the case; and the oscillation when running on the straight, which has been objected to in engines with radial boxes, is thus done away with.



IMPROVED DOUBLE DRUM STEAM PLOWING ENGINE.

The water is carried partly in side tanks and partly at the back of the footplate, under the coal bunker, a very even distribution of the weight being thus secured. The advantages of this type of engine, especially for local and branch line traffic, are obvious, the radial axle boxes being at either end. The engine runs with equal facility in either direction, passing the curves with ease, while the long wheel base renders it very steady vertically, and much lighter on the permanent way than an engine of the ordinary description, which would pass curves of the same radius. These engines have now been running for some months, during which time they have given very satisfactory results, and the makers have supplied engines of the same type to the Dutch Southeastern Railway Company; where they are giving equal satisfaction. We append a list of the principal dimensions and weights:

Cylinders and Motion.

	ft.	inch.
Diameter of cylinders	1	5½
Stroke of cylinders	1	10
Distance apart between centers of cylinders	2	0½
Width of steam ports	0	1½
Width of exhaust ports	0	3
Length of ports	1	0
Diameter of piston rods	0	2½
Length of connecting rod between centers,	5	10
Length of eccentric rods	5	4

Wheels and Frames.

Diameter of leading and trailing wheels	3	6½
Diameter of coupled wheels	5	6½
Distance between centers of leading and driving wheels	7	3
Distance between centers of coupled wheels,	8	6
Distance between centers of hind-coupled and trailing wheels	7	2
Total wheel base	22	10
Width of tires	0	5½
Total side play of leading wheels	0	1½
Total side play of trailing wheels	0	1½
Distance apart of frames	3	11½
Thickness of frames	0	1½

Boiler.

Length of barrel	10	1
Thickness of barrel plates	0	7/16
Thickness of smoke-box tube plate	0	0½
Diameter of barrel plates inside	4	1
Length of fire-box shell outside	6	1
Width of fire-box shell at bottom	3	11
Depth of fire-box below center line of boiler,	4	9½
Length of fire-box inside	5	4
Width of fire-box inside	3	2½
Height of fire-box inside	5	8½
Thickness of fire-box shell plates, front and back	0	0⅝
Thickness of fire-box shell plates, sides	0	0⅜
Thickness of fire-box shell plates, top	0	0½
Thickness of fire-box copper plates	0	0⅝
Thickness of fire-box tube plates	0	1
Length of tubes between tube plates	10	4½
Diameter of tubes outside	0	2
Number of tubes (iron)	189	
Diameter of chimney at bottom	1	3½

	square feet.
Heating surface, tubes	1,028
Heating surface, fire-box	102
Total	1,130
Fire-grate area	17·15
Ratio of grate area to total heating surface,	1:65·8
Ratio of chimney area to grate area	1:13·0

Tanks.

Capacity.....1,400 gallons.

Weight in Working Order.

	tons.
On leading wheels	11
On front coupled wheels	14
On hind coupled wheels	14
On trailing wheels	10
Total	49

OBSERVATIONS ON ENGLISH RAILROADS—THE GREAT SHOPS AT CREWE.

THERE is no place in England where a person interested in the mechanical engineering of railroads will find so much to observe as at Crewe, where the principal locomotive shops of the London and Northwestern Railway are situated. This line has a greater traffic and equipment than any other in Great Britain. The company owns 1,463 miles of road, and, including lines partly owned, leased, and foreign lines, it works altogether 2,444½ miles. It owns 2,315 locomotives, 5,590 "carriages, vans," etc., engaged in passenger service, and 46,305 "wagons" for merchandise traffic. The shops for the maintenance of such an equipment must evidently be very extensive; 5,617 men are employed in them. This number includes those in the steel works, in a large stone yard, and in the signal works, but not in the carriage or wagon departments, which are at Wolverton and Earlestown.

The locomotive superintendent or engineer is Mr. F. W. Webb, one of the most eminent men in his profession. He is assisted by Mr. T. W. Worsdell, whose name is well known in the United States, from the fact that for several years he was engaged in the machinery department of the Pennsylvania Railroad at Altoona. It is therefore possible to study English practice at Crewe with an American light shed on it through Mr. Worsdell's experience. Probably it has been in part due to this, that some features of American practice which differ from English usage have been adopted or tried on this line. Among these are cast-iron driving-wheel centers, of which a large number are now in use for "goods" or freight engines. Some time ago steel was also extensively introduced for fire-boxes, and it may be a matter of surprise to American master mechanics that it was found necessary to abandon its use entirely for that purpose and to return to copper for both the back tube and fire-box plates. It is true that fire-boxes were also made of steel on other English lines, but it was more extensively used on the London and Northwestern road, and it failed there with more emphasis, it may be said, because the steel used was made in the works of that company. Most if not all of it was Bessemer metal, which is not made into plates at all in the United States. It may be added that so far as the writer has been able to ascertain the opinions of locomotive superintendents here, they are unanimous in their condemnation of steel for fire boxes. Its use has been entirely abandoned for this purpose on every road that has been visited. So far as the experience of those who used it could be learned, it seems that it was exactly similar to that of American master mechanics ten or twelve years ago. Any one who will read over the reports of the Master Mechanics' Association of that time will find that the experience of its members in this respect was then identical with that of British locomotive superintendents later. Steel for fire-boxes was then condemned by many, and in fact came very nearly being entirely abandoned; and had it not been that the manufacturers of steel plates recognized the evil, and also saw that unless it was remedied it would result in the loss of all demand for steel for this purpose, our experience and practice would doubtless have been the same as that of our English brethren, and we now should be using copper or perhaps iron where steel is almost universally employed at present. The manufacturers of steel boiler plates, however, instead of submitting to the loss of their business, went to work to improve their plates, and to make a steel which would stand the service for which it was intended. The same complaints were made in America at the time referred to that are made in England now. Our steel failed then by cracking in the most mysterious way. Sometimes plates would fail while the engine was at work; at other times hours, and even days, after the fire was drawn would crack with a report as loud as that of a rifle. The fractures, it was noted, generally occurred in the sides of the fire-boxes, and were always vertical, although they would often radiate from the stay-bolt holes. All kinds of remedies were proposed. The manufacturers at one time urged that the holes should all be drilled and that the plates after flanging and drilling should be carefully annealed. In fact at one time it seemed as though steel would require to be treated so very tenderly that that fact alone would prohibit its use. Corrugated plates for fire-boxes were proposed, and on one or two lines were much used. After a great deal of experiment and experience, though, the manufacturers were able to furnish a material which would stand without taking any of these precautions, excepting perhaps that of annealing the plates after flanging, and now steel fire-boxes are almost universally used on American locomotives. Unfortunately, at this distance from the statistics, it is impossible to give any data concerning the durability of steel, nor are the requisite figures at hand to compare the cost of steel and copper. Probably no more useful piece of work could be done for English railroads than to collect such information, and show, if possible, the reasons why steel will stand the service in fire-boxes in America and will not in England. The fact that, as a general thing, we work our locomotives harder than English engines are worked here, and that our coal has more injurious impurities in it, all seem to be unfavorable conditions. It has been said in England that one of the reasons why steel stands in American engines is that they are kept fired up more continuously than English engines, and are thus not exposed to such frequent changes of temperature. It would probably not be difficult to show that steel fire-boxes do stand in engines which are fired up and cooled off daily. The only unfavorable condition for steel under which English engines work is that the furnace doors used here are usually kept open, which exposes the plates to currents of cold air; but this condition often exists in American engines, although perhaps not so continuously as here.

The steel works at Crewe already referred to consist of a number of Bessemer converters and Siemens-Martin furnaces for the manufacture of plates, rails, etc. The fact that the company makes its own steel, and that it can thus produce plates of that material cheaper than it can either buy or manufacture iron plates, has led to the use of the former material for almost all purposes, excepting for fire-boxes. For tanks, chimneys, ash-pans, and in fact wherever iron plates are ordinarily used, steel is substituted at Crewe. A great deal of work is done by shaping steel plates in dies and formers, and some very complicated forms are thus worked out by means of various ingenious devices which are used. Thus the base of the chimney, by which it is fastened to the smoke box, instead of being a heavy casting, is made of a square plate of steel with a hole punched in the middle. It is then heated and placed under formers, so as to draw out the metal around the hole with the form required to attach it to the chimney. By this means they are made very quickly and cheaply, and of course do not weigh a fourth as much as they would if made of cast iron.

The domes of English locomotives are always placed about midway between the fire box and smoke box, and instead of being attached directly to the barrel of the boiler, as they are with us, usually have a base made of wrought iron with a bottom flange shaped to the curve of the boiler so as to be riveted to it. This base is usually from 6 to 10 in. high, with another flange on top, to which a similar flange on the dome is bolted. As the flanges are usually about three-quarters inch thick, it will be seen that it is a difficult thing to make. In some shops it is made of a heavy piece of angle iron bent into a circle and the ends welded together, the sides being drawn down to the shape of the boiler. At Crewe a round steel plate, an inch or more thick, is taken, and a hole is then punched in the center. After being heated it is bent to the shape of the boiler and a neck is drawn out by forcing a die into the hole and drawing the plate to the shape of another die of the requisite size. After this process and another heat the upper flange is turned and the job is complete. Mud-drums and other parts are made in a similar way.

A very interesting process is that of making the outside casing or covering for the domes of locomotives. Those on English locomotives, as most of the readers of the *Railroad Gazette* know, are made very plain, the top being a perfect hemisphere, the sides a cylinder, and the base or lower edge is drawn out or flared in a kind of a trumpet-mouth shape, so as to unite by easy curves with the barrel of the boiler. These casings are made of two soft steel plates of about No. 14 wire-gauge thickness. It is thus composed of two pieces, which are united in a vertical plane through the center of the dome. The two halves are first shaped in formers to that of one half of the finished casing. The edges are then serrated, somewhat like very large teeth of a saw. These are then bent alternately on one side and on the other, as the teeth of a saw are "set." The edges are then brought together so that the teeth will interlock with each other, and they are then brazed together and the projecting portions of the plates are filed off or hammered down so as to be flush on the outside. The whole is then painted.

Steel, about one-sixteenth inch thick, is also used for the covering of the lagging of the boiler.

The lagging is put on in a somewhat novel way. The material used is heavy felt. As has been found elsewhere, this burns or rather chars very rapidly. To avoid this it is therefore laid on a kind of framework, or, as it is called at Crewe, a crinoline, made of angle and light strap iron, which leaves an air space of an inch or two between the boiler and the felt, thus effectually protecting the latter. Light boards and the steel casing are then put on the outside of this.

As stated before, the shells of boilers are all made of steel on this line, about seven sixteenths inch thick. The longitudinal seams are butt-jointed, with two rows of rivets—that is, one row on each edge of the plate. The circumferential seams are ordinary lap joints, single riveted. Rivet holes and tube holes are punched. Great care is taken to locate all the horizontal seams above the water line. Before the plates are lapped on each other the scale is carefully removed under the laps by an application of sal ammoniac and water, so as to bring the metal in contact. The boilers are tested before calking, first with a steam pressure of 60 lb., and afterward with a hot-water pressure of 250 lb., to see whether there are any defects in the riveting. It is then calked under a steam pressure of 60 lb., first with a flat and then with a round nosed tool. The steel of which the boilers are made is tested by bending a cold test pin double, after being plunged hot into cold water, and also extending a ¾-in. hole to 1¼ in. diameter, by driving a drift into it. The riveting, except in a few inaccessible places, is done by a hydraulic machine. This method is used in England almost universally for riveting.

Mr. Webb has designed a very neat furnace door which opens inward so as to form a deflector for admitting air to the fire. It is operated by a lever on the outside. The deflector is made of cast steel to resist the heat.

The galvanizing of steel plates and many other iron parts exposed to corrosion is very much used at Crewe. Parts of tanks, etc., which corrode rapidly, are all galvanized, and the process is also employed for the iron used for operating signals out of doors. This is all done in the works at Crewe.

In making the seams of tanks a thick piece of paper, resembling cartridge paper, is placed between the plates and is riveted up between them. This, it is said, makes a better joint than can be formed by the usual method.

The crown sheets of the boiler are stayed with bars and sling stays, connected with the outside shell of the boiler.

The mud-ring or "foundation ring," as it is called here, is made deep enough at the corners to take two rows of rivets. This is done to strengthen the plates in the corners which are such fruitful sources of corrosion and trouble.

In making and fitting ash pans, Mr. Worsdell says, much more trouble is taken at Crewe than in America. They are made of 5-16 steel, strongly braced, and with a damper in front. The latter is fitted to the pan, and the pan to the fire box, so as to make them as nearly as possible air-tight. The object of this is to be able to regulate with some accuracy the admission of air below and above the fire, on which the authorities at Crewe think much of the success in consuming smoke depends.

In connection with the steel works Mr. Webb is also using the process of steel casting very extensively. The castings are made of Siemens-Martin steel, just as ordinary castings are, the only difference being that the moulds are lined with a more refractory material (composed chiefly of clay and plumbago) than is used for ordinary iron castings.

In the steel works and in the blacksmith shop a great variety of methods is employed for forging both under dies and by stamping or rather punching out of a solid piece the form of the article required. It would be difficult to explain how this is done, without going into much more detail than is now possible. The dies used consist usually of a pair of cast-iron blocks, one of which is attached to the head of a steam hammer, and the other to its anvil. The form of the article is cast or cut in this casting, so as to form, as it were, a mould of it, as though it was to be cast, one half the mould being in the top die and the other half below. A piece of iron approximating the form of the article to be formed is heated and laid between these dies, and a single blow of the hammer usually completes it. Complicated forms often require several processes, and means of upsetting and squeezing into different shapes must be adopted, which must, of course, vary with the shape and size of the article to be made.

The reverse process is also often used in forging; that is, instead of the object being pressed into the shape required, the superfluous material is punched or cut away, thus leaving the form required. This is done under steam hammers, especially for steel forgings.

At Crewe may also be seen a method of applying heat, and another for applying power, which as yet are unknown or very little used in American shops. These are, first, the gas furnace; and, second, hydraulic power. The first is used in heating plates, etc., for flanging, shaping, etc. All the springs are made in gas furnaces, for which it is admirably suited. Another very convenient application of it is in brazing on the ends of brass tubes. It is simply a small fire-brick receptacle for the tube, so as to confine the heat imparted to it with a vertical Bunsen burner, which throws a very highly heated flame, produced by the combustion of a mixture of gas and air, downward upon the tube. A boy turns the tube slowly in its fire brick bed, and adds the requisite brazing materials, and the work is done.

The other agent of applying power is now used for such a diversity of purposes in England that an American is at first surprised to find how far we are behind our English brethren in this respect. There are, of course, some reasons for this; the principal one being that, until recently, the work which could be done in this way was not sufficiently concentrated to justify the required expenditure. This condition of things has changed and will continue to change, so that these appliances could now, in many cases, be used with very great advantage. Reference has already been made, in a previous letter, to the use of hydraulic cranes, capstans, etc., in shops and stations. In the Crewe shops the riveting machines, spring testers, and presses of various kinds are operated by hydraulic power. In fact, wherever much slowly-acting power is required, there hydraulic pressure may be employed, and the variety of uses to which it may be applied is very much greater than any one would at first suppose.

The predominating type of locomotives used on the London and Northwestern line is one with inside cylinders and without trucks or bogies. About sixty engines, each with a single pair of driving wheels and outside cylinders, are in use, but it is doubtful whether any more of that kind will be built. One of these with driving wheels 8 ft. 6 in. in diameter, with the barrel of the boiler below the driving axle, was built some years ago by a former locomotive superintendent. The boiler has been altered and placed above the axle, but the engine is still running with the same wheels and cylinders. The latter are 17½×24 in. The other engines of this class have 7 ft. 6 in. wheels

The passenger engine now most approved is one with four coupled wheels and a pair of leading wheels in front having a rigid axle. The frames are of the usual English plate type. The steam-chests are on the sides of the cylinders, the valve faces being of course vertical. The two cylinders and the steam-chest (one of the latter answering for both valves) are cast in one piece; special machines are used for planing the valve-seats and trimming out the ports. The space between the valve-seats is about 5⅛ in. Although it is said that with the special machines for that purpose, the work can be done nearly as quickly as it could if the seats were open, yet the operation looks very much like working in the dark. The freight or "goods" engines, as on all English roads, have six wheels coupled, with the same kind of cylinders as the passenger engines, and, of course, the attending crank-shaft. The London and Northwestern Railway is, so far as the writer's observation has gone, the only line in England or Scotland that is using cast-iron driving-wheel centers. These are used, however, only on freight engines. Those for passenger engines, as is universally the case over the whole of Great Britain, are wrought iron. The use of solid-end coupling-rods with a circular bushing pressed in is almost equally common. It is a very rare thing to see a stub-end on a coupling-rod, especially on four-coupled engines. Iron cabs and six-wheeled tenders are also the almost universal rule.

Mr. Webb is now putting on the screw-reversing gear, and is also placing the injectors below the foot-board and attaching the check-valves to the back end of the boiler, with a pipe in the inside of the latter, extending to near the front end. The arrangement is very neat, and is deserving of general adoption.

Many things which were observed at Crewe must, however, be left unnoted, as space and time are both limited. The signal department is especially interesting. It may be said, though, that this branch of railroad art and science has been developed in Europe to an extent of which most American railroad officers are extremely ignorant. It is not alone that English engineers are using devices in signaling which are little known in the United States, but they have evolved a system of laws and principles which must govern all signaling in order to be safe, and which are not merely arbitrary rules, which may or may not be observed, but are of the same immutable nature as the one deduced from experiments on metals, which teaches us not to subject them to strains greater than their so-called limit of elasticity. The system of laws referred to, and the means used to apply them to practice, has been evolved in England after many years of experience, doubtless great sacrifice of life, much profound study, the exercise of the rarest ingenuity, and the expenditure of millions of dollars of money. All, or very nearly all, the railroads of Great Britain are operated by signals constructed in conformity to the laws referred to. Everything that money, ingenuity, legislation, and experience could do to perfect this system has been done; and although it would be folly to pronounce it perfect, yet what seems equally or more foolish is for men who are in almost total ignorance of what has been done here, to attempt to devise improved methods of signaling for American railroads. A visit to the signal department of the London and Northwestern Railway does not, therefore, foster the natural vanity of an American student of railroad appliances, and when he recalls the bumptious attempts at improvements in this direction, so often made by railroad men at home, and the dismal and almost hopeless condition of ignorance of this subject that many, or it might be said most of them, are still in, it does not stimulate him to much national exultation.—*M. N. F., in Railroad Gazette.*

THE RAUB CENTRAL POWER LOCOMOTIVE.

WE present illustrations of a new system of constructing railroad locomotives, recently patented by the inventor, Doctor Christian Raub, of New York city. The object of this invention is to construct a perfectly balanced locomotive, in which the center of gravity is coincident with the vertical median line of the engine, and in which the motive power is located at the middle of the engine in a plane extending through the center of gravity. These two objects being attained, it is hardly possible to overestimate the value of the invention, since the locomotive will then be constructed upon correct principles and according to natural laws. It works from its center, and has its motive power situated in a plane extending through its center of gravity, and has therefore no dead weight.

It is not within the scope of this article to review the various attempts and experiments undertaken in the course of time in this direction, but it may be stated generally that the problem of locating the center of gravity in a railroad

Fig. 2

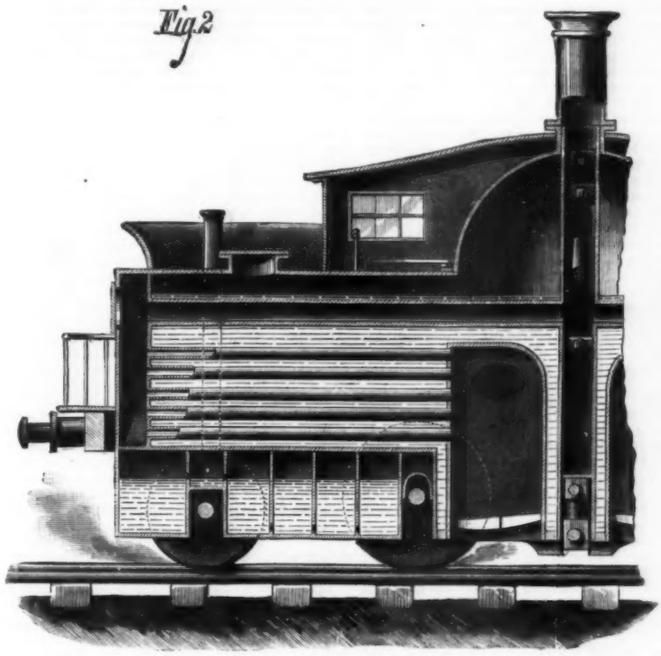
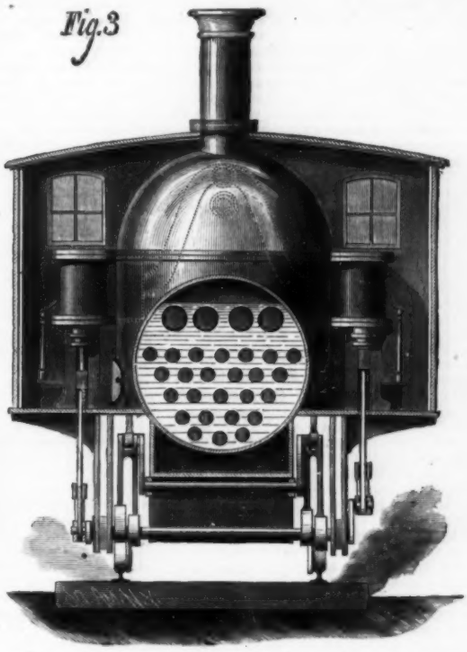
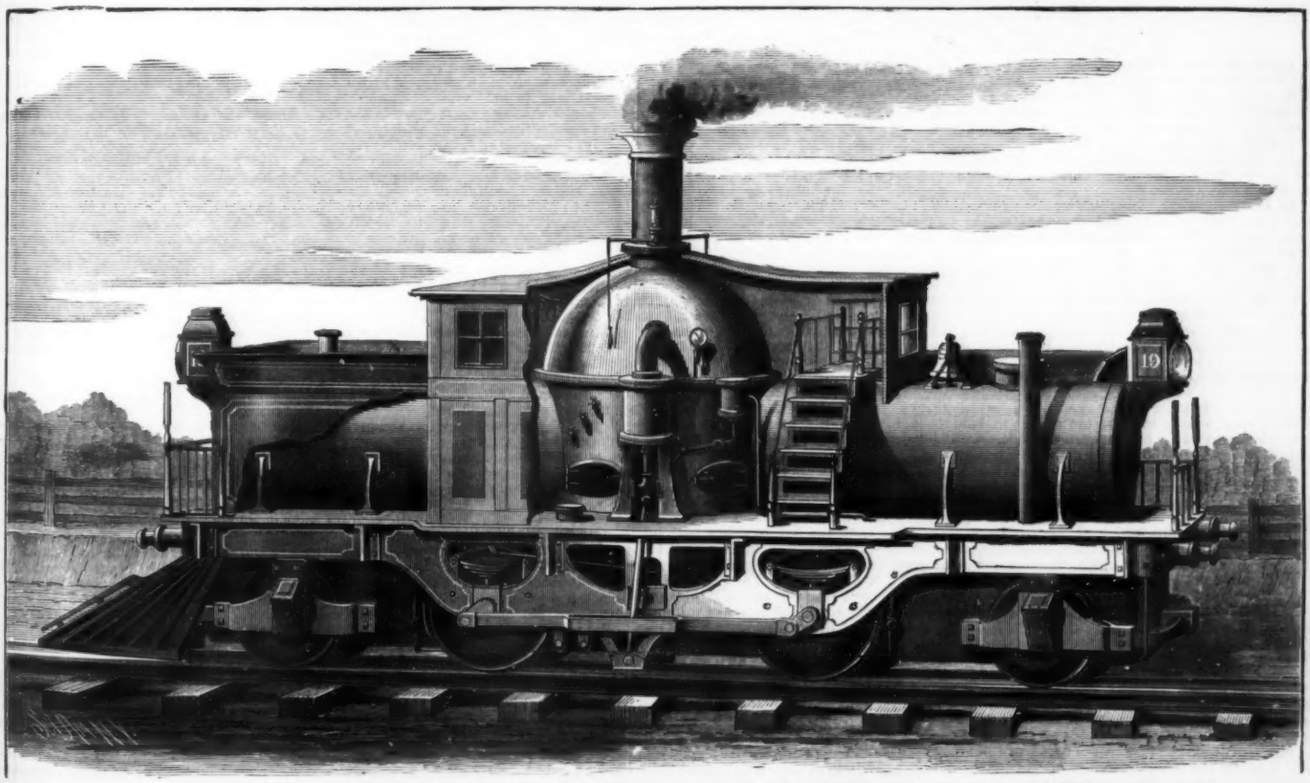


Fig. 3





THE RAUB CENTRAL POWER LOCOMOTIVE.

locomotive upon the center of its base formed by the driving wheels, and to place the motive power at that center, had not been solved before the invention of Dr. Raub; and probably the reason why these attempts have not been successful is, that the fact was not sufficiently realized that Stephenson's system was at variance with the principles above referred to, and that nothing short of a radical change of the whole system of construction could lead to success; any improvement upon the original design, no matter how great, could not overcome the faults or disadvantages which were inherent in the system as a whole.

Dr. Raub, in order to definitely locate the center of gravity, has constructed his engine in such a manner that each half of the total structure, whether divided longitudinally or laterally, is an exact counterpart or duplicate of the other half, both as regards weight and measure; the consequence of this is that the center of gravity is in the intersection of the longitudinal and transverse center planes of the entire locomotive; and by placing his motive power in the central transverse vertical plane of the engine he has disposed the parts of his locomotive to the best advantage for economy and efficiency.

The engravings represent the invention so clearly as to require but little explanation. The whole engine rests upon an oblong platform which extends all around the structure, and which is made wider in the middle to support the engineer's cab, which will be as wide as the cabs now in use; at each side of the engine is a boiler extending longitudinally to the end of the locomotive, each boiler having a separate firebox, which is located in the cab. The boilers have ordinary flues, which terminate in a smoke chamber at the extreme ends of the locomotive, but instead of allowing the heat and gases to escape through smokestacks at the ends, as in the present locomotives, they are conducted through return flues of a larger size (as shown in Fig. 3) to an interior collecting smoke chamber, which thus collects the smoke and gases from both boilers, and allows them to escape through one common smokestack which stands above it. This collecting smoke chamber extends upward and downward vertically through the entire locomotive, and serves not only as a brace to the steam dome which surrounds its upper portion, but also gives an additional support and strength to the entire structure. The steam dome stands in the center of the locomotive, its axis being the exact center of the engine. It is stiffened by the collecting smoke-chamber which extends through it. A separate valved connection is made through this interior smoke-chamber for the steam as well as for the water in the boilers, so that both steam and water can circulate freely from one boiler to the other, or may be shut off if it is desired to use one boiler only. The steam cylinders are vertical, and placed outside the steam dome, their axes being in the vertical transverse plane extending through the center of gravity of the locomotive, and preferably placed as high as possible, so as to take the steam by means of pipes which receive their steam supply from a common opening at the highest point in the steam dome, the opening being closed by a throttle-valve operated in the usual manner. The steam chests are placed inside the dome as shown in Fig. 3.

The driving-wheels are situated equidistant from the center line, and upon them rests the whole platform, and in the center-line, and as near the rails as possible, is placed an intermediate driving shaft, to the cranks of which, on opposite sides of the locomotive, extend the connecting rods from the cross-heads of the piston rods above. The cranks of the two drivers on each side of this vertical connecting rod are connected in the usual manner by a horizontal driving rod, which, near its center, extends downward to the crank of the intermediate driving shaft and is connected with it. The driving rod is slotted in its center to allow the vertical connecting rod free play.

The eccentrics are placed upon the intermediate driving shaft, while the link motions are arranged on an auxiliary shaft vertically above it.

The locomotive may have horizontal cylinders, if they should be preferred. In that case they would be placed lower down in a line with the center of the driving wheels, but in the same central position.

At each end of the locomotive the frame rests upon a truck, but as the whole engine is evenly balanced upon and supported by the driving wheels, the object of the trucks is not so much to support any specific weight, as in other locomotives, as to serve as a guide over curves. Each end truck has one transverse axle with one pair of wheels and a frame which incloses the wheels and is connected by an arc-shaped guide piece, which is transversely guided in a fixed center box at the end of the locomotive.

The water tanks are below the boilers, openings being provided to allow the axles of the wheels to pass through. The fuel is carried in bunks arranged sideways and above the boilers.

A novel and ingenious plan is devised for feeding the boilers. The return flues being situated but a few inches below the water level, it is important that the level should be continually kept up. The inventor has, therefore, arranged a steam pump, which is worked by a lever connection with the main piston, and which injects into the boilers at each stroke of the piston the equivalent of water for the steam used.

These are the main features of this novel engine, which the inventor claims as the first locomotive built upon strictly scientific principles.

The advantages claimed for this new style of locomotive, and to which Dr. Raub has given the appropriate name of central power locomotives, are numerous.

This engine has no dead weight, therefore its whole power can be utilized for drawing freight; and it is claimed that the central power locomotive of any given size will do more work than another locomotive of the same size under the same conditions. The heat is better utilized, as it is led back through the boiler by means of the return flues, and the fuel will be more fully consumed than it is now. The collecting smoke chamber, which extends upward through the steam dome, serves to superheat the steam, consequently dry steam will be obtained, and the steam chests being inside the dome, no loss of steam from condensation will take place. Should an accident happen to one of the boilers, the connection between the two may be interrupted, and the remaining boiler will be sufficient to propel the train to the next station, thus preventing blocks on the road and delays to traffic.

It is claimed that a train may be run at a much higher rate of speed with this engine and with much more safety than now, owing to the balanced driving wheels and the peculiar relation of the parts; and there is less danger of breaking the driving rods and less strain upon the track.

A separate tender will not be required, as both water and fuel are carried upon the locomotive itself; and, furthermore, turn-tables with their necessary attendance will become superfluous, since the locomotive is a perfect double-ender, and runs in either direction with equal efficacy and without any damaging effect to the gearing.

We understand that Dr. Raub is now making arrangements to build several locomotives according to his new system of different patterns and sizes, in order to practically test their merits and superiority and to ascertain the actual percentage of saving in running them.

For further information, address the Raub Central Power Locomotive Company, Limited, No. 51 New Street, Room 12, New York City, Dr. Christian Raub, President.

THE CANADA PACIFIC RAILWAY.

WE have recently made full inquiry with the view of ascertaining something definite as to the route to be followed by this important work, which, after years of disputation, disappointment, and heartburning, has at length been determined upon by the Dominion of Canada. The result of those inquiries, which were most courteously answered, has been curiously vague. We learn that the line has been commenced without accurate survey or estimates having been prepared, and this fact at once places this undertaking without the category of railways known to all previous experience. Perhaps, however, we should except from this the great American line to San Francisco, and the knowledge of difficulties overcome in the construction of that important communication may remove those which we should ourselves conceive to be inevitable to the realization of a work commenced upon such apparently insufficient data as are available for the Canada Pacific Railway. We must, of course, admit the circumstances to be exceptional. The only condition to which the Canadian Government binds itself is a *pro rata* cash payment per mile of line completed by the company which has undertaken to carry the work through, and the grant of land to it on either side of the length of line completed, the total money payment to be twenty-five million dollars, and the total land grant twenty five millions of acres. It may, therefore, be assumed that, as far as the Government of Canada and the interests it protects are concerned, it matters little how far the estimates of constructive cost vary in the long run; but it will be far otherwise, we should say, as regards those who intrust their money to the venture.

Canada is a country in which political strife runs high, and party feeling seems to have an undue and regrettable prominence in every question of public enterprise. It was without wonder, therefore, that we read in Canadian journals the assertion that the bargain now concluded was "iniquitous," and might be superseded by another offering far greater pecuniary advantages to the Government. Such is said of every great undertaking for which a government is responsible, and so we shall not attempt to discuss whether or no the agreement which the syndicate of the Canada Pacific Railway is economically a wise one or not; but, accepting it as an accomplished fact, just offer a few remarks upon the route it is probable the new railway will take, and the advantages it will offer to settlers in Ontario and Manitoba, but more especially to those of British Columbia, which distant province will, by its agency, be brought for the first time into direct communication with the Atlantic Ocean.

It was, indeed, to secure this last advantage that the work was first proposed. The British Columbians made its construction the condition upon which they consented to become part of the Canadian Dominion, and the delay which occurred in its fulfillment nearly caused them to sever the newly established connection. We have been favored with a pamphlet published by the Canada Pacific Railway Company entitled "The Fertile Belt," for such is the term applied to the country through which it is proposed to carry a large section of the railway. In that pamphlet is a map showing approximately the course proposed to be followed by the railway to join the shores of the Atlantic with those of the Pacific Ocean. The work to be done within the provinces adjacent to the former is, we judge from the map, the connection of lines already in existence, Montreal, in the province of Quebec, being the starting point. A railway about 350 miles or so in length is at present open from that city to Callander on the shores of Lake Nipissing. From the latter place a branch is suggestively marked upon the map to meet the steamer traffic upon Lake Superior, opposite to Sault Sainte Marie, where a narrow strait connects that lake with Lake Huron. This will be about 275 miles in length, but this branch does not appear to be included in the company's contract with the Government.

Going back to the starting point before named, Callander, we continue our examination of the main route. Rounding the northern shores of Lake Nipissing, the proposed new line is indicated for a distance of some 650 miles, until, at a place called Thunder Bay, it nearly touches Lake Superior at the western extremity of that lake, and forms a junction with a railway already in operation between Thunder Bay and a point near the eastern end of the Lake of the Woods, which has a present length of some 220 miles. The new company has to effect the junction of this section with a line already extending toward it from the city of Winnipeg, the capital of Manitoba. To do this, about 70 miles seem to be necessary. The passage of the well-known Red River is then reached, and at this point will be tapped the traffic on Lake Winnipeg, a fine sheet of water some 350 miles long extending northward, until the Nelson River debouching from it gives direct communication with Arctic seas. Leaving Winnipeg, which is perhaps one of the most rapidly developed cities the world has ever known, a rail already laid brings us to Rapid City, and *en route*, touches the southernmost end of Lake Manitoba, an inland sea about 200 miles in length. At this point, Rapid City, we leave behind us all trace of completed railways, and enter upon what the directors of the Canada Pacific Railway term the "Fertile Belt." We have reason to believe from what we have recently read respecting this region in the columns of our contemporary, *Colonies and India*, that such a description of it by no means passes accuracy of representation. The weight of evidence demonstrates it to be one of the finest wheat-growing countries in the world, and it is through its rich lands that the Government of Canada have ceded to the Canada Pacific Railway Company grants on either side of their line, by the sale and settlement of which the company hopes to recoup itself for the large outlay it will have to undertake. This belt extends apparently for about 800 miles, and the line will have to cross the important rivers called Assiniboine and Saskatchewan and their tributaries, the waters of which are the chief agents in fertilizing the country to be passed. At the western extremity of that "fertile belt" the foot of the far-famed and dreaded Rocky Mountains is reached.

Up to this point, so far as we have been able to judge, the constructors of this new railway will have had tolerably plane-sailing, but when the spurs of the Rocky Mountains are entered there will be encountered engineering difficulties second to none experienced in railway construction. It is evident from the varied suggestions for crossing this range of mountains, which have appeared in *Colonies and India*, that there is a wide diversity of opinion as to the most favorable pass for crossing. We see that the map from which we have been working indicates the Yellow Head Pass as that prominent in the minds of the directors of the company, but the journal above referred to has on several occasions notified objections raised to it and other passes considered by local engineers to offer greater advantages. At the present time, we understand, the company has a large surveying staff engaged in the examination of every suggested pass, and, of course, every estimate that may have been formed of the cost that will be involved in surmounting this difficulty must be considered to be purely hypothetical, and it is mainly with reference to this obstacle that we have referred in our remarks to the very doubtful data upon which the estimates for this line have been based. In fact, on the works required to overcome it, a million more or a million less than any present estimate may have to be spent. The doubtfulness of the route to be here ultimately adopted of course renders it impracticable to say anything with definiteness as to the mileage that will have to be constructed. Possibly, we shall say, the surmounting of the Rocky Mountains range, reckoning from the extremity of the Fertile Belt to their westernmost foot, will be 250 to 300 miles. Very probably, we think, the latter figure will be reached. Once descended into the fertile plains of British Columbia, the line passes by Lake Kamloups and reaches the shore of the Pacific Ocean at Port Moody, where the directors may rest from their labors. This final section from the foot of the Rocky Mountains to Port Moody we may assume to be about 270 miles.

Having thus taken our readers a short gallop across the entire continent of North America, we may summarize the figures we have given *en passant:* Montreal to Callander, 350 constructed miles; Callander to Thunder Bay, 650 still to be made; Thunder Bay to Lake of the Woods, 220 constructed; connecting link with present line from Winnipeg, 70 to be constructed; through Winnipeg to Rapid City, 275 constructed; from Rapid City, through the "Fertile Belt," to foot of Rocky Mountains, 800 to be constructed; across Rocky Mountains 300, and to Port Moody 250, both to be constructed; total 845 constructed, 2,070 to be constructed.

We see from the foregoing statement that the total length of line required to connect the Atlantic and Pacific oceans will be about 2,915 miles, of which 2,070 still remain to be undertaken. The estimate upon which the contract between the Canadian Government and the Canada Pacific Railway Company is based assumes only 1,950 miles, and it is possible—though we are without definite information on the point—that some of the unfinished sections we have included in our estimate will have to be completed independently of the company.

It seems to us that it will be wise to assume a total of fully 3,000 miles as required to achieve the object in view. To this mileage, as far as regards the intentions of the company, though apart, we presume, from its contract, has to be added the branch shown on the plan as designed between Callander and Sault Sainte Marie, which we estimate at 275 miles. This length, added to the 2,070 miles required as the main line, gives a total of 2,345 miles to be constructed by the company to carry out its designs as shown upon the map.

We have thus given a general outline of the route to be followed and the length of railway to be constructed throughout it. A uniform gauge of 4 ft. 8½ in. is to be maintained along the entire system, and the standard of construction is to be that of the Union Pacific Railway of the United States. The contract binds the company to commence work on the 1st July of the present year, and active operations are now in progress. The date of full completion is fixed for the 1st May, 1891. We understand that on the fulfillment of the contract the company will have handed over to it by the Government, in full possession, the 841 miles of railway at present completed, and this fact must not be overlooked in estimating the advantages which will be secured to its shareholders. The enterprise is one of the greatest yet undertaken in railway construction, and we sincerely wish its promoters every possible success, and congratulate British Columbia on the prospect now before it of at length realizing what has been its cherished dream and its just demand.—*The Engineer.*

A BURNING OIL TRAIN.

A DESTRUCTIVE oil fire occurred on the New York, Lake Erie, and Western Railroad, near Sloatsburg, about twenty miles from this city, yesterday. A full train of cars of crude oil was coming East down the grade when a coupling gave way near the engine. For some unaccountable reason the latter part of the train broke into several pieces, and the various tanks came down hill at a frightful rate of speed, the momentum increasing every second. The engineer at once perceived the danger and allowed the engine to go at its best speed. Finally, after an exciting race of over two miles, the bottom of the grade was reached. The engineer soon noticed that the runaway tanks were fast gaining on the engine, and before he could make enough distance the first tanks collided with the tanks which had remained attached to the engine. In an instant the end tanks were on fire. At first it was but a small stream of oil running from a leak in a tank over a hot journal, but before any sand could be thrown on it the fire communicated to the oil in the tank. The engineer at once separated the undamaged tanks from those which had been injured by the collision and removed them a distance down the track.

All the necessary precautions had been taken to prevent the coming of other trains, and help was at once telegraphed for. The sudden jar of the collision caused the tanks in the rear end of the train to telescope and the oil to catch fire, so that the train was burning simultaneously at two places. The morning express from the West soon came along, and the passengers assisted the train hands in fighting the flames by throwing sand and dirt on the burning cars. Plenty of assistance soon arrived from the neighboring villages, but the heat soon became so intense that it was impossible to get anywhere near enough to them to give them battle. The wrecking train, with a large number of hands, soon arrived from Jersey City, and every endeavor was made to save as much property as possible. The flames shot hundreds of feet into the air, and the few trees which were in the neighborhood were soon consumed. The flames hissed and the burning oil boiled out of the tanks until the generation of gas became too much and the tank exploded with a deafening report. Luckily there were no houses or other buildings in the neighborhood, and the damage was confined to the

crude petroleum, the tanks, track, and ties. It made sad havoc with the latter. As the oil burned to the ground after the explosion it destroyed the trucks of the cars, the wheels becoming red hot in the blaze. The ties were consumed and the rails curled up in the heat like scraps of paper, the ground being saturated with the oil.

The fire began at nine o'clock in the forenoon, and at noon it was apparent that very little could be done toward putting it out. The telegraph poles had been destroyed and communication with the Jersey City office cut off. Men were set to work building a line of wires round the fire, and soon a wire was in working order. As a last resource a cannon was borrowed from a neighboring iron works and the train hands loading it with railroad iron began a bombardment from the best point they could find. Soon a hole had been shot in the tank nearest the fire and the oil ran down the embankment where the loose earth soon absorbed it. All the cars possible had been moved away and the extinguishing of the fire was soon only a question of time. When the half empty tank exploded soon after it caught fire the flames began to gradually die out. Five large tanks had been consumed, and all that was left of them was scrap iron. It was five o'clock last evening before the work could be begun on the hot earth, and it was ten o'clock before the express train left with its hungry passengers. The fire could be seen and the explosion heard for miles about the conflagration.—*Patterson (N. J.) Press, Sept. 24.*

A NEW STYLE OF PASSENGER CAR.

TWENTY passenger cars are being built at the Boston and Albany car shops at Allston for use in the suburban travel on that road. One train of five cars is now completed, an inspection of which shows a complete departure in construction from those now in use. The increasing demand of the patrons of the road for rapid transit and frequent trains led to the need of such trains, and the especial object sought was lightness in weight and light and ventilation for the interior. To this end the services of Mr. Richardson, the architect, were employed. He has made the plans for all above the trucks. The exterior of the cars is finished in narrow, rounded sheathing, that closely resembles corrugated iron. Large windows reach from the letter board about half way to the bottom, and they are so wide that they are separated in most places by only a narrow strip, and the lettering is simply "Boston and Albany Railroad" on the letter board, with "Suburban Service" and the car's number on the side. The interior is finished in paneled chestnut, thus doing away with the ornamented canvas head lining. The seats are of rattan. They run lengthwise, in order to facilitate quick exits. The cars are lighted by eighteen or twenty single kerosene bracket lamps, and the package racks are very long. Good ventilation is obtained in the old way by opening the deck windows, which are covered by fine screens. The doors contain large plate glass, and the general appearance is plain, but nice. It is feared that the cost of the first train will exceed that of the old style cars, and also, that the cars will exceed the old ones in weight. Officials from the several roads running from Boston have inspected these cars, and are highly pleased with their appearance. The wheels are imported from England, and have steel tires, with wrought iron spokes and hubs.—*Boston Herald.*

DRYING-STOVE FOR PRINTED SHEETS.

WHEN printed sheets issue from the press they are always very damp, and if one were obliged to dry them by open air it would take a very long time, and the more so from the fact that, being piled one on top of the other, no circulation of air can take place between them.

The object of Mr. Renault's drying-stove, represented in the accompanying engraving, is to dry the sheets rapidly by hot air, so that they can be given into the hands of the binder very shortly after they are printed. The apparatus consists of a structure in masonry, lined with boiler-plate and divided into three compartments. The sheets of paper, in packages of one hundred, are hung over movable drying tubes, which are supported at their extremities by angle irons.

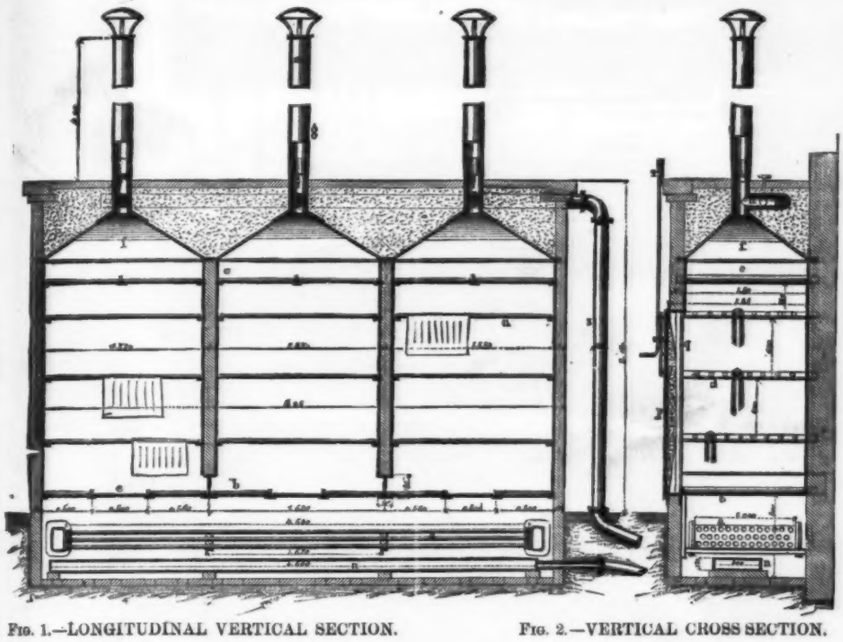


FIG. 1.—LONGITUDINAL VERTICAL SECTION.

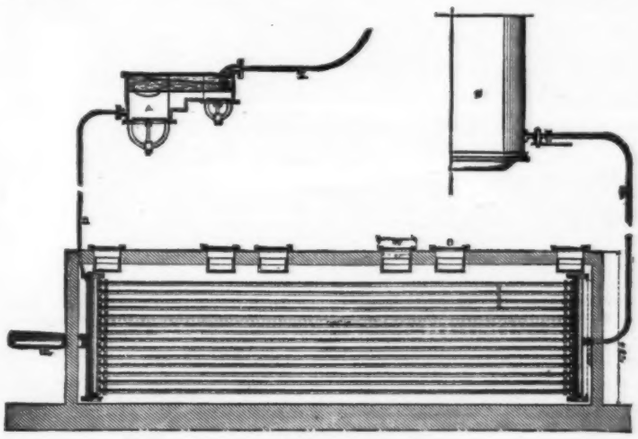


FIG. 2.—VERTICAL CROSS SECTION.

FIG. 3.—GROUND PLAN.

RENAULT'S DRYING-STOVE FOR PRINTED SHEETS.

The air, which is furnished by a blower, is forced into a perforated pipe, *n*, and passes between tubes, *a*, heated by steam, where it attains a temperature of from 70° to 80°.

After having been in contact with the printed sheets, it traverses the aperture, *e*, in the iron plate ceiling, and enters the chimney-hood, *f*, which is surrounded by a heat-absorbing material, and returns to the blower through the pipe, *i*. The following description of the cuts will allow the arrangement of the apparatus to be readily understood:

a, heating apparatus; *b*, perforated floor for entrance of hot air; *c*, solid cast-iron plate, covering the passage through which the paper is introduced; *d*, movable tubes over which the paper is hung; *e*, perforated ceiling for escape of the damp air; *f*, hoods of galvanized iron; *g*, aerating chimney; *i*, pipe leading to the blower; *m*, pipe through which the air is forced by the blower; *n*, perforated pipe for distributing the air; *o*, inlets for cold air from the exterior; *p*, padded oaken doors giving access to the stoves; *q*, boiler-plate doors giving access to the stoves; *r*, lever for maneuvering the chimney valves; *s*, steam boiler; *t*, steam pipe; *u*, exit for condensed water; *v*, automatic apparatus for allowing of the escape of condensed water; *x*, escape tube for the condensed water, which may either be returned to the boiler or emptied into a hot-water reservoir.

COUNTERMANDS AND PROTECTIONS.

EVERY department of manufacturing industry would be greatly facilitated and its products cheapened if the sale of these was direct and certain in the first instance. The margin required to insure the sale is now unnecessarily large, and, in the end, the consumer pays the difference—a difference which need not be interposed, because it adds to the cost of almost everything without profiting the several hands through whom the goods pass. In English trade the manufacturers are struggling with one form of this difficulty which is comparatively little known here, namely, the forward dating of the obligation given by the first purchaser, a device which extends an ordinary four months' credit four or six months longer, and sometimes to a year. If the market is not sharp and active, the manufacturer has two risks to run, the one of piling up goods which may not after all be taken at paying prices, or the other of parting with his goods to a dealer for post-dated paper, which gives the dealer an opportunity to sell and realize their value months before he is required to pay for them. The opportunity for abuse is great, and, of course, the manufacturer must insure himself in the price he demands, or in some device for cheapening or evading to which he would not have been compelled to resort if he had sold for cash and a moderate profit.

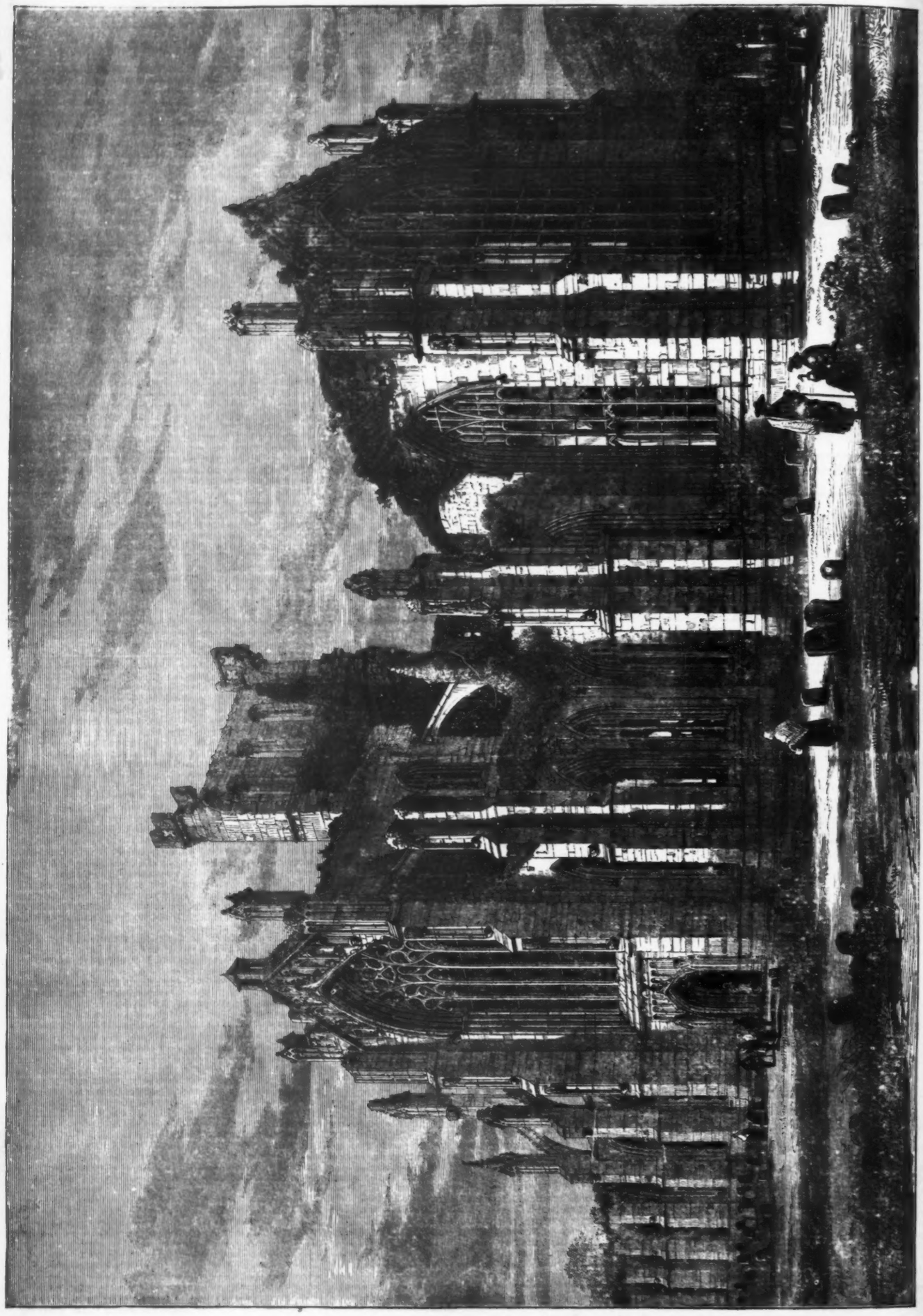
In the United States a worse abuse exists, derived from the sharpness of the pressure on both manufacturers and dealers, occurring when prices fall rapidly and continuously on stocks the materials for which were bought at high prices and on a rising market. These changes of price have been frequent and severe, especially during the last ten years, and, as a consequence, a practice of countermanding orders has been developed that has no legal or moral defense. It is the custom to order freely on a rising market, the dealer or commission house then desiring to get everything possible into their hands, to profit by the quick sales and good profits then prevailing. Such was particularly the case, during the first four or five months of 1880, in the textile trades. Prices were high, and the whole production of the machinery in operation, say on May 1, of that year, was, as a rule, ordered fully forty or sixty days ahead. But in June the demand slackened, and before the close of that month hundreds of countermands had been sent to the manufacturers by the dealers, practically repudiating their contracts, and leaving the manufacturers with large quantities of goods urgently ordered a few weeks previously, but afterwards refused.

In these cases the cost of the materials and labor had advanced largely, and the manufacturer incurred unusual cost in preparing to make the goods ordered. Cotton hosiery and warp yarns were worth 30 cents per pound in April, 1880, in comparison with 20 or 22 cents in November previous. In this, as in most similar cases, the profit on goods ordered bore no equality to the risks taken in buying materials for higher prices and in paying the higher wages necessary in preparing the goods under pressure. Then, at a time intermediate between the order and any possible delivery, the countermand was sent, and the great majority of the producers made no attempt to obtain redress. The reasons for submitting were various, but chiefly because some defense as to style or quality could be interposed which never would have been thought of if prices had not declined. The lots ordered varied from ten to fifty cases, and the hope of getting over the difficulty without a contest would usually be entertained, at least for a time. Sometimes the lots ordered would be taken with an abatement, or reclamation for quality or style would be made in place of an absolute countermand—any way, in short, being taken to throw the loss off on the part of the dealer, through whom alone the manufacturer could then dispose of his fabrics.

This outrageous and illegal practice, for it can be described in no milder language, is due to the violent and extreme changes in prices characteristic of the dry goods markets, and to the defenseless position generally held by the manufacturers. But it is anomalous and inexcusable, and would not be tolerated in any other business. The facts fully told would be scarcely credible, and it is a mistake that the wide-spread injury resulting a year ago was not made the subject of a detailed exposure, and just condemnation of those who, while abundantly able to keep them, repudiated their obligations by wholesale.

Another practice in the dry goods manufacturing trades has grown up, which, while not involving so much discredit as that of countermands, is still unfortunate to the manufacturer or commission house permitting it. It is termed the protection of goods sold, or the guaranty of the buyer against loss by subsequent decline of price. A merchant from a Western town takes an assortment of prints—ten to twenty cases or more—under a protection. The goods are at once delivered, and he reports them sold when he chooses, remitting the price prevailing when he sells them, not when sold to him. He may sell them at a high price, and choose to report them later, when a lower price prevails, or when he has made a second profit by a second use of the money. The account is not closed until the buyer chooses, in short, and often the right to recall or transfer them is not reserved. In one case where such right was reserved, and where it was suspected that an untrue report was made that none were sold, an order of transfer compelled the purchaser to pay for the whole at an advanced price, as he had, in fact, disposed of them. It is an objectionable practice to deliver goods not sold absolutely, and these protections originate in times of great depression, remaining to embarrass and demoralize trade after all occasion for them has passed away.

These protections are also unknown in other trades, and would not be thought of in wheat or pork. It is the rule generally to conclude all bargains absolutely and to take all risks fairly in other departments of trade, and the anomalies in manufacturing and selling dry goods would not long survive a vigorous and unflinching exposure. The slaughtering of consignments by dry goods commission houses is scarcely less culpable than the open repudiation of contracts by countermands, and in periods of depressed or falling prices it has caused frightful losses and irreparable injury. During 1877 and 1878 the practice of selling out at wrecking prices was frequent, but in 1880 there was much less than usual, and the hope is general that the worst of that class of misfortune is over. At any rate the condition of dependence which compels the manufacturer to consign for any sale or any sacrifice has greatly changed for the better, and they will now be found better defended against either class of abuses than at any previous time.—*Bradstreet's.*



MELROSE ABBEY.—DRAWN BY S. READ.

MELROSE ABBEY.

AT the foot of the Eildon Hills, on the banks of the Tweed, three miles below Abbotsford, is the village of Melrose, thirty-seven miles from Edinburgh, with the ruins of the beautiful Abbey. Sir Walter Scott's residence was chosen in this neighborhood, for the sake of those romantic and sentimental associations which he had evoked in his "Lay of the Last Minstrel;" and most of our readers are familiar with the eloquent passage in that poem which describes the moonlight view of "St. David's ruined pile." All ruins look noble and pathetic by moonlight; and those of Melrose, especially, are improved in effect by it. We must confess that a less congenial impression is made on the susceptible tourist, on arriving in the unromantic noontide hour,

When the gay beams of garish day
Gild, but to flout, the ruins gray

The local surroundings, a railway station, the back premises of a hotel, and several modern villas, all close to the Abbey, considerably spoil its æsthetic effect.

As for the architectural history of the Abbey, it is not "St. David's ruined pile" at all. King David I. of Scotland, who was canonized by the Pope, and was afterwards called "a sair saint for the crown," founded a Cistercian monastery in this place, and other religious convents at Dryburgh, Kelso, Jedburgh, and Holyrood, about the beginning of the twelfth century. No part of the building whose remains are now admired at Melrose is older than the fifteenth century. There was first an old Melrose, founded by St. Aidan of Lindisfarn, at a short distance from the Melrose of which we speak. King David's Melrose Abbey, which must have been in Norman style, was destroyed in 1322, by the English, when they retreated from Scotland, after the final defeat of Edward II. by Robert Bruce. The Abbey was then rebuilt by King Robert, but in 1385, when Richard II. attempted another invasion of Scotland, the English again indulged their national spite and malice by destroying Melrose. It was again rebuilt, with the greatest magnificence, as we can now see, in the following century. The prevailing style is Gothic, approaching to the perpendicular, with an admixture of the Continental Flamboyant, and with profuse decorative sculpture, altogether of a foreign character. The English could not let it be; and in 1545, when Henry VIII. made war on Scotland, the Abbey was gutted by Sir Ralph Evers and Sir Brian Latoun, who were soon afterwards defeated and killed by the Scots on Ancrum Moor. A few years later there was another English invasion, led by the Earl of Hertford, when the work of wanton destruction was rendered more complete. The materials of the Abbey buildings were partly used for the houses of the village. What now remains is the south aisle of the church, part of the nave, and part of the north aisle, the choir with its aisles, and the transepts with their aisles. The nave and south aisle are much deformed by later erections, the place having been at one time converted to the use of the Presbyterian Kirk. The south transept has a noble window; but the east window, in the chancel, described by Sir Walter Scott, is really beautiful—by daylight, as well as by moonlight. Whether Michael Scott, the Wizard, is really buried here, or the heart of Robert Bruce, we cannot pretend to affirm.—*Illustrated London News.*

WINNIPEG, MANITOBA.

THE Marquis of Lorne, Governor-General of Canada, on his way to visit the great Northwest Territory, which extends a thousand or twelve hundred miles beyond Lake Winnipeg and the Red River, to the Rocky Mountains and to the frontier of British Columbia, recently sojourned a week in this new city. Though bearing the same name as the lake, the town of Winnipeg is not actually situated upon its shores.

The view we have engraved shows this town of Winnipeg, or rather city, as being the capital and seat of government of a Province, Manitoba, one of the confederated Provinces forming the grand Dominion of Canada. Our readers will see, at a glance that Winnipeg does not stand upon the shore of a lake, but upon the bank of a river, nearly opposite to the confluence of the two rivers, where the Assineboine, flowing eastward from the western prairie country, joins the Red River, which flows from south to north, and enters Lake Winnepeg at Selkirk, about twenty miles north of the city. There is also a Lake Manitoba, from which the name of the new Province is derived, and which lies thirty or forty miles northwest of the city of Winnipeg; indeed, there is an extensive chain of lakes, receiving the streams of many large rivers, the largest being the Saskatchewan, all of which finally enter Hudson's Bay on its western side. They form a vast system of inland navigable waters, by which, it is expected, the corn and other agricultural produce of the immense Northwest Territory, with the aid of the Canadian Pacific Railway, will be conveyed to Port Nelson, in Hudson's Bay, for shipment and commercial export in the summer months; the voyage from Port Nelson to Liverpool being shorter than from New York.

Manitoba will, at the same time, be very soon placed in direct railway connection, to the eastward, with the existing Canadian navigation from Lake Superior, admitting the passage of ships of fifteen hundred tons thence to the Atlantic Ocean; so that its facilities of export trade will exceed those of any other place in the western parts of North America. The whole Province of Manitoba, but especially the Red River district, surpasses every land of the continent in the rich fertility and depth of its soil, while the climate is admirably suitable for wheat-growing, for root crops, for stock-raising, and for the culture of many kinds of fruit. It is also comparatively exempt from certain insect pests and other perils that beset some of the prairie countries farther south.

The city of Winnipeg is but ten or twelve years old. This place was previously known as Fort Garry, one of the Hudson's Bay Company's stations, for purchasing furs of the Indians; but there were also a few hundred Scotch settlers, whom Lord Selkirk placed here between 1811 and 1816. It was called the "Red River Settlement," and was considered hopelessly out of the world. Since the transfer of the territorial dominion from the Hudson's Bay Company to the Canadian Government wonderful progress has been effected. The population of Manitoba, a province measuring about 100 miles and 135 miles in different directions, already numbers 114,000, and their agricultural industry now begins to contribute handsomely to the wealth of the Canadian Dominion. It is nothing to what it will probably be in another ten or twenty years. Winnipeg, to be sure, as the *Times* correspondent with the Marquis of Lorne has lately remarked, is not a pretty town, nor yet in perfect order, but 15,000 inhabitants dwell there in great prosperity, and mean to see it become, at least, the equal of Chicago, or of Cincinnati. The principal street, Main street, which is 132 feet wide, is lined with handsome and substantial buildings of cream-colored brick, good houses and shops, public edifices, the town hall, the post-office, the market, the Dominion Land Office, the custom house, and several colleges; while numerous large churches and institutes, the banks, hotels, newspaper offices, and a variety of shops and stores, prove the activity of social civilization. The other chief streets are Portage avenue, which crosses Main street at right angles, and is of equal width; Burrows avenue, 99 feet wide, and several of 66 feet width, laid out on a very regular plan. There are three public parks for recreation. On the opposite bank of the river is the French half-breed village of St. Boniface, the seat of an influential Roman Catholic missionary bishopric, which has done much good among the Indians.—*Illustrated London News.*

THE CORRECT AND INCORRECT THING IN COTTON.

WHEN Commissioner Miller, the agent of the Atlantic Exposition, was in Manchester, England, he sought the best of the interested manufacturers of cotton for some information born of practical investigation. Technical education is a power in this age, and the more we impart it the more we improve our rising and our risen generation. I made some inquiries of Commissioner Miller that brought out the following:

"I met in Manchester a most worthy and highly esteemed resident of Oldham, of the name of William Marcroft," said Commissioner Miller, "and here are his views on a topic

WINNIPEG, THE CAPITAL OF MANITOBA, IN THE CANADIAN DOMINION.

MELROSE ABBEY.—DRAWN BY S. READ.

Constitution through your correspondence will do well to ventilate, as the marked inequalities of our cotton are closely criticised. Mr. Marcroft, speaking of a few injuries done to cotton before it arrives in England, said:

"1. The staple of low middling and ordinary cottons is largely in consumption in Oldham. Yarns from 20 to 50 counts are spun in the same ball. The staple is long, medium, and short, arising, as we think in Oldham, from different species of cotton seed and on lands of a varied soil, or soil shaded both south and north, getting more or less of the sun's rays, and sometimes we find unripe cotton. This is a very serious diversity and inequality to us for our machinery and for our increase in demand. It is desirable that the same length of staple should be equal in the same spun ball.

"2. Cotton in being baled at the gin-house is too much negiected as to the dirt, which we would gladly pay for by its absence, if weight to the bale be the only idea of the ginner. The dirt and dust should and can be got out by a fan. Seeds, leaf, and dirty trash ought to be left in America to fertilize the land. We have no use for them here, and they retard our industry, and consequently curtail our consumption of what we are reasonably supposed to be buyers of—clean cotton. The purchaser in England buys these bales with confidence, and willingly pays the price. But he does not appreciate the disregard for that *mean* and *mum* which should ever characterize fair trading, and furthermore, he does not want gin-house 'trash' at clean cotton prices. Dirty cotton, like dirty conduct, injures producer and consumer.

"3. A bale of cotton ought to be a bale of cotton, and

not a 'half breed' of dirt, deception, and short-sighted diplomacy with some 'long staple.' And a bale of cotton ought to have at least ten hoops on it. Some Indian cotton bales should be seen in America as an example of neatness, cleanliness, and excellent hooping. They have always ten hoops, and are compressed into 20x25 inches square, 5 feet long or thereabouts. They are compared to the American bale as neatness is to slovenliness, and economy is to extravagance. It is amazing that intelligent Americans are so backward in the correct, and so forward in the incorrect mode of baling cotton, while the uncultured Asiatic Indians are their superiors in this regard. Where lies the fault? In the financial greedy or the indifferent planter? Perhaps both. The Indian bale requires less covering, less expensive handling and storage, is less tattered and torn, and by being less in size is kept cleaner and with much less waste of cotton. The American cotton bale to all intents and purposes, as a rule, on its landing in England is nothing but a wasteful rag-bag in appearance. It is a disgraceful package, with a sort of pre-arranged 'leakage,' that bespeaks lack of thrift and suggests an inducement to theft.

"4. Cotton on arriving at Liverpool ought to be placed in warehouses of factors of your own country, and sent over by a company or *bona fide* organization created by yourselves of America. You would thereby increase your trade, enlarge our confidence, and make a better commercial amity and comity. The cotton interest is too large and too important a one to be sacrificed on its moral and material progress. Investigate the *modus operandi* of the cotton industry from the plantation in America to the pier in Liverpool. It is full of themes your forthcoming Atlanta Exposition would alone be justified in by severe scrutiny and strong comment. If you have only this theme your Exposition will be a success.

"5. The cost of consigning cotton brokers, the cost of selling brokers, the charges of sampling brokers, who in nine cases out of ten are grossly ignorant of sampling pure and simple on its intelligent form, the cost of petty peculation, the cost of pompous banking, the cost of dozens of excessive extravagant handicaps on cotton would be a fitting topic for Atlanta's Exposition, and on it Oldham and Manchester, Bradford and Nottingham would and should gladly join. The planter and manufacturer should be brought face to face with facts that certainly can increase production industry, and consumption.

"6. The warehousing of cotton in Liverpool, even under the present *regime*, need not be greatly expensive. If the sample shown and the classification could be depended upon this warehousing expense might be readily reduced. The cotton when lifted out of the ship might be at once forwarded by railway to the buyers, who are already contracted with for these 'arrivals,' 'futures,' 'deliveries,' and all the other absurdly increasing terminology that serve to bewilder the vendor and vendee. This is done to a large extent already with Egyptian cotton; why not also with American? We are wedded to our old idols in this matter a great deal too zealously.

"7. Credit for cotton bought by Oldham companies and others of cotton spinners is usually paid for on receipt of cotton. If cotton on being used is found inferior to the buying samples, could there not be in a large town like Oldham a resident arbitrator whose decision should be fair and final in such an evidently equitable matter?"

The above seven paragraphs I give to the best of my memory as they were conveyed to Commissioner Miller. Are they not worthy of consideration in Atlanta?—*London Correspondent Atlanta Constitution.*

INDIA-RUBBER RING ON A MACKEREL.

A RATHER singular incident in connection with the life of a mackerel came to hand here yesterday. While one of our small mackerel boats was fishing for mackerel with hook and line in our bay a mackerel was caught with an India-rubber band around it, and which had been there for a long time, as the skin under the band showed considerable abrasion, with here and there occasional wounds. The probabilities are that about a year ago a fishing pleasure party were out somewhere along our coast who had been drinking ginger beer, when small mackerel of six or seven inches were probably plentiful, and one of the young, restless imps who are always to be found among such a party, must have drawn out the elastic ring or band from the bottle and slipped it over the head of a live mackerel, and just below the pectoral fins, and then have thrown the fish back again into the sea; and, as a consequence, the poor mackerel must have had a weary and miserable year of it. And here, I am sure, some of our lady social reformers may learn a lesson on tight lacing with a vengeance, for, as the fish fed and increased in size, the band kept its firm grip around him, and only allowed him to grow to the extent of the elasticity of the band; and so tenacious was the hold, that whereas the mackerel had grown to eleven inches in length and four inches in circumference above and below the band, under it the girth was only three inches. In fact, the poor mackerel had really a wasp waist. Moreover, from this ligature being so constantly and firmly around the fish I estimate that it lost from its natural growth two inches in length and one inch in girth in the year.—*Cornwall (Eng.) Correspondence in Land and Water.*

UPON THE USELESS PART OF THE OBJECTIVE, AND A NEW STOP.

I SHOULD like to say something about a subject lately minutely examined by Herr Meydenbauer and myself, the importance of which, particularly in taking landscapes, should not be under-estimated. I mean the question: How far the whole aperture of the objective contributes to the creation of the picture, and whether it is not more injurious than useful? Should this actually prove to be the case then a remedy for the defect must be sought.

If one focuses sharply (preferably upon a landscape) a lens affixed to a camera the whole of whose focusing glass it represents distinctly, and then, withdrawing the focusing glass, with the head under a dark cloth examines the interior of the camera, one will see that the interior sides of the camera are illuminated by part of the field of sight of the objective, and are distinctly recognizable in all their details. Now, it is quite impossible that this circumstance should exert no influence upon the picture, especially when emulsion plates which are so sensitive to weak light are used; since, even in perfectly new cameras, the walls or bellows are hardly ever so perfectly dead and black as not occasionally to reflect some light when it falls very obliquely.

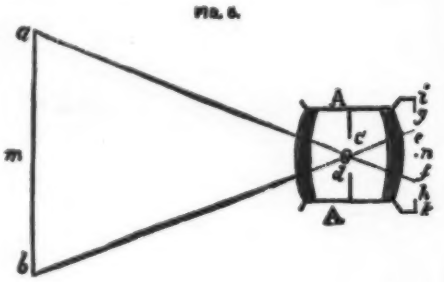
It often happens that the whole surface of the focusing glass is never required for the picture at all, in which case a proportionately small part of the light which reaches the interior of the camera is utilized. Certainly the light which falls upon the surroundings of the plate will not do much harm, because it cannot be reflected directly upon the plate; but it is even then not wholly without influence, since, even in the best glass, there is always some degree of diffusion of light, and, consequently, such exists in the objective, and, taken along with the reflection from the various surfaces of the lenses, cannot but do some damage. Though these two drawbacks have to be taken into consideration along with the rays of light really employed for the image, it is undoubtedly at one's option to cut them off partially at the same time as the superfluous rays, and thereby really to increase the brilliancy and clearness of the image.

In order to discover what rays may be cut off from the objective, A, suppose two lines, $a\,o\,f$ and $b\,o\,e$, to be drawn from the extreme limits of the picture field, $a\,b$, and passing through o, the center of the central stop, $d\,c$. Now, let there be placed in front of the objective a screen, $i\,g\,h\,k$, having an excision in the center, it will be clear that if the distance, $e\,g$ and $f\,h$, be equal to half the diameter of the central stop, $o\,c$, the screen will not retain a single ray of light used for the picture, $a\,b$, but only cuts off those refracted from points lying beyond the picture. Therefore, the distance of the picture from o is equal to $m\,o$; that of the screen, which we shall call the "light stop," is equal to $n\,o$. Thus we obtain the equation, $g\,h = c\,d + a\,b\,\frac{o\,n}{o\,m}$, for the dimensions of the light stop; or, in other words, the dimensions of the light stop, decreased to the diameter of the central stop, stands in proportion to the dimensions of the picture as do the distances of both from the central stop. From the rule thus formulated we draw the following conclusions:

1. While the distance of the light stop from the objective remains the same, if the central stop be enlarged the light stop must either be enlarged to the same extent, or else the surface of the picture must be diminished. 2. If the light stop be right in front of the objective—whether it be used with the full aperture or with a smaller diaphragm—it can only be used for a proportionately small picture, while it is always useful when much stopped down. 3. If, for example, the light stop be removed from the objective until $\frac{o\,n}{o\,m} = 1$, then the light stop may very well be used alone for portrait objectives without the central stop.

As will be seen, the employment of the light stop is uncommonly convenient for all photographs taken with small central stops, and should, therefore, never be omitted in taking landscapes or making reproductions. And even in taking portraits—for which pneumatic shutters are now so much affixed to the objective—it may, without any very great difficulty, be affixed and used in addition to the generally

FIG. 6.



used tunnels or tubes employed to ward off side light from the objective.

In conclusion, it may be remarked that one may easily convince himself experimentally of the reality of the supposed influence exerted upon the plate by the useless part of the objective. With that object in view place the camera in front of a landscape, and, instead of covering the useless part, cover the useful part of the objective. Expose a sensitive emulsion plate, and on developing one will find that he has obtained, not certainly a direct picture, but, particularly on the side next the sky, decreasing from the edges toward the center, a fog—stronger or weaker according to the internal condition of the camera—whose presence furnishes the required evidence. — *Franz Stolze, Ph.D., in Br. Jour. of Photography.*

PHOTO PRINTING IN MUNICH.

ALBERT'S ESTABLISHMENT.

THEY are early people in Munich. There is no need to wait until noon to make a call for fear you may interfere with the commencement of the daily labor. At nine o'clock you will find the busy establishments here in full swing, and, possibly, if you ventured there at eight, nobody would feel put out but yourself. Going to work so early reminds one of the visit of the Emperor of Brazil some two years ago, when his Imperial Majesty always began the serious labors of the day about six. The comic papers, we remember, made very merry over the Emperor being up betimes, and published humorous diaries of what was done in the small hours; but it was not such fun for those who had to rise from a comfortable bed, hours before their wont, to attend upon his Majesty. We ourselves were called upon to explain the various applications of photography to military purposes while the morning air was still raw and chill, and, before seven, had gone through a demonstration of the carbon process to his Majesty's entire satisfaction, if not to our own. Herr Albert, it seems, has done a good deal of work for the Emperor of Brazil, and, we believe, holds an appointment under his Majesty. Thus it comes about that early rising and photography are coupled in our minds as we are here in Munich, paying a visit "at home."

Mr. Court-Photographer, Joseph Albert, has his establishment in one of the best streets in Munich, the Karlstrasse. He holds high rank as a portraitist, and, as we pass into the broad entrance, between handsome columns, we see many magnificent examples of his work. The reception-room is small, but well appointed, and on the walls are some large direct portraits with six-inch heads, as well as some highly-finished enlargements, all of them of notable persons. The Emperors of Germany, Russia, and Austria, the boy-like King of Bavaria, as well as potentates from Saxony and Hanover, are here represented, from negatives taken by Herr Albert himself. All the prints are, however, in silver, and there is not a single example of carbon printing on the walls. Herr Albert prints either by silver or by Lichtdruck, and, if you like, he will take you a carte portrait and furnish you with five hundred copies of it for thirty marks, or thirty shillings; a thousand copies cost £2 10s.; or, if it is a cabinet portrait, then a thousand copies cost £3 10s. The prints are only upon writing paper if delivered at this price, and thick plate paper or cardboard pictures would, naturally enough, cost more. For glazing, an extra twenty per cent. is charged.

We must not, however, lead our readers to suppose that very high class Lichtdruck portraits are furnished for this amount. As most of us know very well, to give good Lichtdruck impressions, not only must the negative be suitable, but the object as well. A gentleman in a black hat and black coat could not be satisfactorily reproduced by Lichtdruck except under much difficulty, and in ordinary circumstances, people who know what silver prints are, would not be satisfied with impressions in Lichtdruck. In a word, while very much can be done in collotype printing, and, in the case of reproductions of paintings, etc., the most satisfactory prints produced, we have not yet got so far as to print off ordinary portraits by steam; and when Lichtdrucks are particularly well done, we may be sure no pains or time have been spared in their production.

A PHOTO PRINTING MACHINE.

Collotype printing is not merely done by hand-presses nowadays, but by machinery; and here across the yard we see two so-called *Schnellpressen* (quick presses) at work. A gas-engine of six-horse power is employed to drive the machines, and each machine requires the attention of a skilled mechanic and a girl. The press is very like the lithographic quick-press with which some of our readers are doubtless acquainted. Upon a big steel bed lies the little collotype printing block. It is a piece of glass nearly half an inch thick, its uppermost surface carrying the bichromated gelatine image. The block seems very small for so large a press, for, as the metal bed moves to and fro, and the big cylinder that carries the paper revolves, only a double cabinet print results therefrom. The mountain moves, and a mouse issues forth. It takes, perhaps, a minute to produce the pair of prints. At this particular machine they are printing copies of "Schützenlisl," a work just now much in request by the Munich public. The negative is from a huge painting of a Munich beer-girl—a lively young person indigenous to the soil, who trips about among her patrons with half-a-dozen foaming tankards in each hand—and as there is a good deal of gradation and large quantities are required quickly and cheaply, the Schnell press is employed in preference to the slower and more accurate hand machine.

Let us watch the printing for a moment. The glass printing block, with its brownish film of gelatine, moves horizontally to and fro, and, as it does so, passes under half-a-dozen ink rollers, which not only apply ink, but disperse it. Some of the rollers are of leather, and some of glue, and whenever the printing block retires from underneath them, an inked slab takes the place of the block, and imparts more ink to the rollers. It is the man's duty to see that the ink is duly carried to the rollers, and applied by the latter in sufficient quantity; while to the girl, who stands at some height above the machine, falls the task of placing a sheet of paper around a huge cylinder, which, in revolving, presses against the block, and thus secures an impression on the paper. Sometimes as many as eight different rollers are employed for inking—the surface of the block being touched by all as it passes underneath them—for the difficulty in working by machinery is to apply the ink as delicately and equally as possible.

It is necessary at intervals to damp the block, and when the printer in charge finds this to be the case, he stops his press for a few minutes. The gelatine film from the first has been impregnated with a little glycerine, which serves to retain moisture, and now a little more glycerine and water are applied by means either of a cloth or sponge. Then, previously to resuming work, a leather roller is passed over, to remove surplus moisture, and the block is again ready for printing.

The quick presses in use at the Albert establishment will produce from 800 to 2,000 copies a day, but, as we said before, the work is obviously not so fine as that produced by a careful printer with a hand-press. At the same time, there is a vast amount of work that naturally falls to the lot of the Schnell press. The printing of pictures for catalogues offers a wide field. Hatters, ironmongers, engineers, bookbinders, tailors, furniture dealers, etc., etc., are all beginning to find out the value of photographic illustrations, and Lichtdruck renders great service in permitting them to place before the public representations of objects for sale in a most novel and satisfactory manner.

The actual preparation of the printing blocks we shall detail in our "At Homes" at Herr Obernetter of Munich, and Herr Löwy at Vienna, merely remarking here that Herr Albert, no more than his colleagues, does not practice the old method of Lichtdruck, in which two films of bichromated gelatine are applied. Herr Albert's original plan—and he was the first to employ Lichtdruck practically, if we except Garnier's beautiful process—was to apply a preliminary coating of bichromated gelatine to the thick glass plate, the film being exposed through the back of the glass, and thus rendered insoluble and tightly cemented to the surface; this firm film served as a basis for the second sensitive coating that was afterward impressed by the negative. This double treatment of the thick glass plate is now definitely abandoned in most Lichtdruck establishments, and, instead, a preliminary coating of soluble silicate and white of egg dissolved in water is employed. This solution must be very dilute, it must be prepared fresh, and last, but not least, the silicate must be entirely free from caustic potash; otherwise the result is never perfect. The preliminary film is exceedingly thin, and, prior to the application of the bichromated gelatine, it is rinsed with water, so that an open porous surface may be obtained. The printing, which is done in an ordinary printing frame, is usually conducted with a stripped negative, but a reversed negative taken on patent plate can be pressed sufficiently in contact to give a sharp impression.

Most Lichtdruck prints are treated with shellac varnish after drying, and in this way are made to look very much like silver prints, for which they are frequently sold. Carefully printed Lichtdrucks on matt plate paper are not varnished, these being generally used for book illustrations.

We pass from the Schnellpress room into the ordinary silver printing room, where a revolving table for vignettes at once attracts notice. It is a round table about four feet in diameter, upon which the printing frames are laid. The motive power is a large clock, or rather the works of one, the clock being set in motion by two heavy weights, such as

one sees attached to the ordinary Dutch clock. "It is a very simple affair," says our friend; "I constructed it myself. The table moves very slowly, but goes on all day, if you pull up the weights occasionally." We saw the vignettes thus automatically printed, and they were very finely graduated.

In Herr Albert's establishment, the cabinet portrait style is most favored by the public, the charge made for a dozen pictures being 27 marks or shillings; but then Munich, it must be remembered, is altogether a cheap city.

PHOTO PRINTING IN COLORS.

Some specimens of color printing in Herr Albert's studio deserve mention. Herr Albert has been experimenting with some success on the method which is usually connected with the name of Ducos du Hauron. A painting is photographed three times; the first negative is taken through a red screen, the second through a blue screen, and the third through a yellow screen. Albert employs colored liquids for his screens, and in this way he secures three negatives, in the taking of which respectively the rays of the three primary colors have been absorbed. The negative taken through the red screen is then printed upon red carbon tissue, and the other two negatives printed respectively with blue and yellow tissue. Then the three prints in red, yellow, and blue are superposed, and the picture is finished. By working in this way, Herr Albert claims to have reproduced a colored picture of Lemercier, which had been produced from eighteen stones (and therefore contained eighteen different tints), in all its pristine beauty. As the original was not at hand for comparison, it was impossible to say how far success had been secured, but certainly the Albert pictures are very pleasing and interesting. To talk of the process as one of photographing in natural colors is, of course, nonsense, for there is no relation between the colors absorbed by the screens and the particular pigment which happens to be in the carbon tissue; but, as an important experiment, the matter deserves notice. But more satisfactory still than the compound pictures in colors, was a compound picture we saw (from the three negatives) printed in monochrome or sepia; the painting was here reproduced far more satisfactorily than when a single negative only was employed for printing. In effect, the colors of the original picture appeared to have been more truthfully translated into monotone by taking three negatives under the particular conditions; so harmonious, indeed, was the result, that we should not be surprised if in future, in the photographing of paintings, recourse is not had to this particular method, or a modification of it.—*Photo News.*

ELECTRICITY ON TRAMWAYS.

ALTHOUGH several years have elapsed since steam was first used to draw cars on street tramways, nothing like a satisfactory result in a commercial sense has as yet been obtained from any engine devised for the purpose. We do not assert that it is impossible to work street tramways by steam for a less sum than horse traction would cost, but no one has succeeded in doing it for any length of time. The working expenses of a tramway are very much heavier in proportion than those of a railway. The average outlay on the principal railways of Great Britain is about 51 per cent. of the receipts, leaving 49 per cent. as profit. But the working expenses of the metropolitan tramways are about 90 per cent. of the receipts. The cost varies in different districts and at different times. It has risen to as much as 97 per cent. of the receipts, and it has fallen to about 80 per cent. A very large proportion of the outlay is incurred for traction. Horses cost much money, do not last very long, and are expensive to maintain. There is, therefore, a powerful inducement held out to directors to try any substitute for the costly and delicate horse. As we have said, the steam engine has not succeeded in taking the horse's place. Under these circumstances, there is a good opening for the introduction of any feasible, or apparently feasible, scheme for dispensing at once with horse power and with steam locomotives.

In America some success appears to have attended the system of haulage by endless ropes laid in a groove in the street, devised by A. S. Hallidie, and described and illustrated in *The Engineer* for 10th October, 1879. The compressed air engines of Beaumont and Mekarski must not be overlooked. But it is more than probable that electricity supplies the best solution of a difficult problem. Indeed, a careful examination of the nature of the problem goes far to show that all the conditions are favorable enough to an electrical solution of it.

There are two ways in which electricity may be used for the intended purpose. One has been patented by Siemens, and has been very fully described in our impression for July 8, 1881. Electricity is generated by a dynamo machine at one end of the line, and transmitted either by a wire or by one of the rails to a dynamo motor fixed on the car to be moved. The rails can be used to transmit the current when the tramway is laid on country roads, or in places of little traffic. But it is evident that a street tramway in a crowded thoroughfare could not be so used. Dr. Siemens gets over the difficulty to a certain extent by using an overhead wire, hung on supports, and communicating with the tram-car by the aid of a little traveler running on the suspended wire, but this device is quite inapplicable to the conditions of metropolitan street traffic. If electricity is to be used to draw metropolitan tram-cars, then some form of locomotive carrying the means of generating electricity must be employed, or the locomotive and the car can be combined in one. Until the other day it would have been commercially impossible to do this. It is true that a dynamo motor might have been fitted to a street car, and that the car could carry a battery competent to work the motor and move the car; but the cost of the zinc used up in the battery would have been very much greater than the cost of horse-power, and besides certain practical difficulties, which will at once suggest themselves to electricians, would have been encountered. The Faure battery, however, puts the whole question in a new light. That battery, as we have had occasion to explain, does not store up electricity in any way; but by passing a current from a dynamo machine through it for a sufficient time, such changes are wrought in the lead and minium, of which it is composed, that the battery is brought into a condition to restore a large part of the power expended upon it in effecting the change. Very exaggerated notions concerning the Faure battery have, we are sorry to say, been set afloat by those who ought to have acted more prudently. But after largely discounting all that has been said and talked about it, the fact remains that the Faure battery places at our disposal a moderate store of power in a form fairly convenient for use. It is unfortunately impossible at present to obtain any accurate data concerning the true dynamic value of a pound weight of Faure battery. If we take one estimate and regard 60 lb. of battery as representing 1,000,000 foot-pounds, it follows that each pound of battery is equivalent in round numbers to 16,000 foot-pounds; one horse power exerted for one hour is equivalent to 1,980,000 foot-pounds, and $\frac{1,980,000}{16,000} = 123{\cdot}7$, say 124 lb.

It is more than probable that Sir William Thomson's estimate that 165 lb. of battery will give two horse power for an hour represents very much more than could be got in practice, and from all that we can learn it seems that it would be unwise to regard a pound of Faure battery as worth more than 8,000 foot-pounds. Consequently, one effective horse power for one hour represents 248 lb., say 250 lb. of battery. Now, although two horses can draw a tram-car, it would be rash to assume that two horse power could do the same thing. It would be necessary to provide at least four horse power. This represents 1,000 lb. of batteries; the dynamo motor and its gearing will weigh at least 500 lb. more. We may take it that a tram-car driven by Faure batteries will weigh 15 cwt. more than it otherwise would; but this additional weight will require more power to propel it, say another horse. We shall not be far from the mark if we say that one ton will about cover all the extra weight. Nothing approaching this has been done with a practicable steam engine which would last more than a few days. Indeed, the more successful steam tramway engines have weighed from five to six tons. We now, however, have a very important question to solve, namely, that of adhesion. Assuming that the wheels of a tram-car are coupled, can it move itself? The weights of tram-cars vary very much; we may assume that an unloaded metropolitan car weights 2½ tons, to this we must add one ton for the batteries, and at least half a ton for extra framing and augmented size of scantling. This gives us four tons; next we have forty passengers weighing about 2½ tons. The gross weight, therefore, of a fully laden tram-car would be 6½ tons. The resistance to traction of street tramways is very considerable; at six miles an hour it is not much less at any time than 20 lb. a ton, and is often very much more. Then $6{\cdot}5 \times 20 = 130$ lb. The steepest grade to be climbed may be taken at 1 in 30; this would represent 485 lb. The maximum continuous tractive effort needed would be $485 + 130 = 615$ lb. Six miles an hour is 528 ft. per minute, and $\frac{528 \times 615}{33,000}$ = ten horse power very nearly, or twice that actually provided. It is evident, therefore, that the weight of battery which we have named would not suffice to move the tram-car for an hour up an incline of 1 in 30. On the other hand, no incline of 1 in 30, anything like six miles long, is traversed by metropolitan tram-cars. Indeed, only comparatively short hills are met with, and something would be gained on descents to compensate for losses on ascents. But the figures we have given show that it will be indispensably necessary to provide means for varying the power of the dynamo motor through wide limits. Another reason for this is supplied by the fact that the resistance offered by the tram-car at starting will be very much greater than when it is running. How the power can best be made variable remains to be seen. Two-speed gearing may be provided, as in traction engines, the tram-car ascending hills slowly, but this does not appear to be the best plan. It would be far better to adopt an arrangement by which more or less battery power may be brought to bear on the dynamo motor to suit the demands of the road and the traffic.

We have yet to consider whether this extra power can be used up by the car. The weight on the four coupled wheels will be 6½ tons; on railways we may reckon on an adhesion of one-sixth of the insistent weight on the driving wheels; on a street tramway it is not as much. It would be unsafe to count upon a coefficient of more than one-fifteenth, or say 970 lb. But at six miles an hour on an incline of 1 in 30, a tractive force of but 615 lb. is needed, or but about one twenty-fifth of the insistent weight. We see here that the self-propelled tram-car has a great advantage over the steam hauled car. A steam locomotive, weighing at least five tons, would be needed to pull a car which when loaded would weigh about five tons. The gross load would be ten tons, but the load available for adhesion would be only five tons; and it is not difficult to perceive that a co-efficient of adhesion of much less than one-twelfth would not suffice to work the traffic. So far, everything is in favor of the Faure battery system, but certain points remain to be considered—one of the most important is the means to be adopted for working the traffic. The re-charging of the exhausted batteries is a work of time, consequently it would be necessary to provide at the terminus a suitable house into which the car might be run while charging was going on. This implies a certain amount of demurrage for each car. If, on the other hand, batteries were kept ready charged, then means must be devised for removing the dead batteries and replacing them with fresh batteries.

This could be done by grouping them all together and lifting them out with a crane, but it implies the removal of the car from the road for a certain period. This condition must, however, be complied with by all mechanically worked cars. It is not an insuperable objection, but it must be allowed for. After every drawback is taken into consideration, it will, we think, be found that a great deal remains to be said in favor of the scheme. Indeed, there are at this moment but two other devices which can be compared with it. One is the use of compressed air, the other is the use of compressed gas to drive a gas engine. The objection to both is that they probably cannot be made to pay for the same reason that steam will not pay. The cost of repairs eats up all the profits. But excessive repairs are to a large extent needed because the machinery is reciprocating, and this defect is common to the steam, air, and gas engine alike. But in the case of electricity the motion is rotary, and the cost of repairs would no doubt be very small. This is a great point in favor of electricity as a motor for tram-cars, and ought not to be overlooked. Before, however, any step can be taken to adapt the Faure battery to the required purpose it is essential that some definite statement of facts concerning it should be put forward by competent and disinterested authorities. Sir W. Thomson appears in the guise of an enthusiast whenever he has occasion to refer to it, and yet he is the only one on whose statements concerning it, it would be safe to place much reliance. Others who speak about it are obviously either ignorant or naturally biased as to its merits. We make no reference to the speculators who seem determined that whatever else the battery may do it shall make money.

The time has, we think, arrived for placing the battery in the market as a something to be bought and sold in the ordinary way of business. Until this is done it seems to be hopeless to expect to obtain any trustworthy evidence as to what it can really do. There is reason to believe that the figures we have given concerning it are correct, but we should be sorry to guarantee their accuracy.—*The Engineer.*

FAURE'S SECONDARY BATTERY.

To the Editor of the Electrician:

SIR: For the first time since my battery was presented to the public I beg, through the medium of your impartial publication, to give the result of my experiments with it. But first let me dispose of a matter which has wrongly taken prominence in the various controversies on the subject of this battery. I refer to the relative merits of the work done by M. Planté and myself in this subject, and the relative merits of the batteries which bear our respective names.

You will be pleased to learn that neither M. Planté nor myself have had anything to do in these recriminations; in fact the note which was at first presented by M. Dumas to the French Academy of Science was properly submitted by M. Reynier to the approbation of M. Planté, and kindly revised by the latter, who quite recently again, I have been told, positively disclaimed any connection with the publication of invidious comparisons. Indeed, M. Planté can well afford to be liberal, and hold the same relative position towards the Faure battery as the great founder of the steam engine holds relatively towards the not by any means unimportant engineer who first introduced tubes in the steam boiler. That this comparison is correct we have it on the authority of the words you have italicized in an article on this subject in your last issue.

M. Planté has also the merit of being clear in the exposition of his ideas and researches, and in his remarkable work, "Recherches sur l'Electricité," he tells us exactly how his battery is made, how it is "formed," and what it does when so made. Referring to this last point we read that a battery can furnish a constant current through fifty meters of copper wire one millimeter in diameter, say one ohm during one hour. Now, if we take the electromotive force at 2·20 volts, we find for the work so given out

$$\frac{2{\cdot}20^2}{1 \times 9{\cdot}81} = 0{\cdot}5 \text{ kilogrammeter}$$

per second during one hour, or an absolute total of 1,800 kilogrammeters. And for the sake of comparison we may also say that the above battery would furnish a current of 2·2 webers for an hour. As Planté batteries may not be in the hands of every one of your readers, and as I was fortunate enough to obtain an assorted supply before the scarcity set in, I will give a few figures which are the results of my experiments, and somewhat corroborate the above statements. The best cell that I could procure, and which had been nearly two years in formation at the maker's in Paris, gave me when properly charged a current of twenty webers during five minutes. The two lead electrodes are each one millimeter in thickness and 65 millimeters long, by 20 centimeters deep. The amount of suboxide of lead which had been formed upon the positive electrode I found by drying and weighing to be 75 grammes. I will at once here make a comparison. In some of my round cells, having electrodes of the same size as the above, that is 65×20, I have placed upon the positive electrode 2,000 grammes of red lead (a similar quantity being also placed upon the *negative electrode*). The current which this arrangement furnished me was about equal to 20 webers during two hours and a half, or nearly proportionate to that furnished by the Planté battery, taking into account the relation $\frac{2,000}{75}$ of lead oxide brought into action in both batteries. The least perfect of my Planté cells, which had been "formed" during three months only, gave me only about one-fourth of the above work. I state simply facts, but it is said that the above mentioned perfect Planté battery might have been made in three months instead of two years. Let it be so, and let us suppose that the Faure battery has no greater capacity of storage than three or four times that of some of the old Planté batteries in existence, still I beg to say that it exists, and is perfectly well covered by valid patents, and as such will be of great value to the electric industry. Upwards of twenty-five tons of Faure batteries have been made, and experiments on a commensurate scale carried out during a year of silence, and from trustworthy experimental work I have acquired the certitude that there are great things in it.—*C. A. Faure.*

FORMS AND FUNCTIONS OF THE ELECTRIC DISCHARGE.

ON the Monday evening during the meeting of the British Association, Mr. Spottiswoode, Pres. R. S., delivered a lecture on "The Electric Discharge: its Forms and Functions," in the course of which he said: We may now fairly ask whether the phenomena which we have been studying have any counterpart in the larger operations of nature which are going on around us, and whether the conclusions to which we have been led afford any explanation of observed facts. Many natural phenomena doubtless fundamentally depend upon electricity; how many we hardly yet know. But there are two in particular, namely, lightning and the aurora—which are unquestionably electrical, and whose correspondence with the spark proper, and with the discharge in rarified gases respectively, has often been noticed. In the thundercloud we have an aggregation of aqueous particles small enough to remain, temporarily at least, suspended in the air. All of these, it would appear, are similarly electrified, and by their mutual repulsion, are restrained from further coalescence. By their presence the ground below the cloud becomes inductively electrified in the opposite sense, and as soon as the cloud by its motion comes within sparking distance, or by an increase of its charge attains sufficient tension, a spark discharge takes place, which as we have seen above is a flash of lightning. A similar action may naturally take place between two clouds oppositely electrified. The electrical tension required for a flash of lightning is, of course, enormous. It has been calculated that, in order to produce directly from a battery of the most favorable construction a spark of 42 inches, equal to that given from my great induction coil, from 60,000 to 100,000 cells would be necessary, while for a flash of lightning a mile long not less than 3,500,000 cells would be required. There is, moreover, another kind of lightning to which the discharge in our vacuum tubes offers, to say no more of it, considerable analogy—namely, that commonly known as ball lightning. The appearance of ball lightning is described as that of a luminosity or ball of fire moving generally toward the earth, in a direction more or less oblique, and disappearing in most cases before reaching the ground. In some tubes, the exhaustion of which is very moderate, say, having a

pressure of several millimeters of mercury, it happens not only that the blocks of light termed entities by Mr. De La Rue, are formed, but also that these entities travel along the tube from the immediate neighborhood of the positive terminal to a finite distance in the direction of the negative, and then disappear. It would seem not unreasonable to suppose that ball lightning is due to conditions not dissimilar to those of such tubes—namely, to a discharge occurring in the upper regions of the air, at an elevation of, perhaps, 20 miles, more or less, where the pressure is very moderate—that is to say, greater than that under which an auroral-like display could take place, and yet less than that which would give rise to a true spark or ordinary flash of lightning. We have not unfrequently present in regions at moderate elevations, say from 20 to 50 miles, all the conditions necessary for the production of an auroral display. And not only so, but our experiments enable us to determine, at all events approximately, some limits of elevation within which this phenomenon can occur, and thereby to check the very divergent estimates of those who have observed it. Estimates of the altitude at which the auroral discharge takes place have been made from simultaneous observations at different points, and these have ranged up to 50 or 60, and even to 281 miles. But even the lowest of these appears to be improbable. The pressure at which the resistance of air is least is a little less than 0·4 of a millimeter of mercury; and the corresponding elevation is about 38 miles. A vacuum tube measured by hundred thousandths of an atmosphere would correspond to an elevation of a little more than 81 miles. Through a hydrogen vacuum at this pressure Mr. De La Rue failed to obtain a discharge with 11,000 cells; and he adds that, "it may be assumed that at this height the discharge would be considerably less brilliant than at 38 miles, should such occur." It seems to me a well ascertained fact that in high latitudes there are fewer thunderstorms and more auroras than in lower latitudes. This fact points to the conclusion that, after a disturbance, the redistribution of atmospheric electricity is effected by one process or by the other, according to, or rather in consequence of, the meteorological differences between arctic, temperate, and tropical regions.

ELECTRICAL HORTICULTURE.

ON SOME APPLICATIONS OF ELECTRIC ENERGY TO HORTICULTURAL AND AGRICULTURAL PURPOSES.*

By C. Wm. Siemens, D.C.L., LL.D., F.R.S.,
Memb. Inst. C. E.

On the 1st of March, 1880, I communicated to the Royal Society a paper "On the Influence of Electric Light upon Vegetation, etc.," in which I arrived at the conclusion that electric light was capable of producing upon plants effects comparable to those of solar radiation; that chlorophyl was produced by it, and that bloom and fruit rich in aroma and color could be developed by its aid. My experience also went to prove that plants do not, as a rule, require a period of rest during the 24 hours of the day, but make increased and vigorous progress if subjected (in winter time) to solar light during the day and to electric light during the night.

During the whole of last winter I continued my experiments on an enlarged scale, and it is my present purpose to give a short account of these experiments, and of some further applications of electric energy to farming operations (including the pumping of water, the sawing of timber, and chaff and root cutting) at various distances not exceeding half a mile from the source of power-giving useful employment during the day time to the power-producing machinery, and thus reducing indirectly the cost of the light during the night time.

The arrangement consists of a high-pressure steam engine of six horse power nominal, supplied by Messrs Tangye Brothers, which gives motion to two dynamo machines (Siemens D), connected separately to two electric lamps, each capable of emitting a light of about 4,000 candle power. One of these lamps was placed inside a glass house of 2,318 cubic feet capacity, and the other was suspended at a height of 12 feet to 14 feet over some sunk greenhouses. The waste steam of the engine was condensed in a heater, whence the greenhouses take their circulating supply of hot water, thus saving the fuel that would otherwise be required to heat the stoves.

The experiments were commenced on the 23d of October, 1880, and were continued till the 7th of May, 1881. The general plan of operations consisted in lighting the electric lights at first at 6 o'clock, and during the short days at 5 o'clock every evening except Sunday, continuing their action until dawn.

The outside light was protected by a clear glass lantern, while the light inside the house was left naked in the earlier experiments, one of my objects being to ascertain the relative effect of the light under these two conditions. The inside light was placed at one side over the entrance into the house, in front of a metallic reflector to save the rays that would otherwise be lost to the plants inside the house.

The house was planted in the first place with peas, French beans, wheat, barley, and oats, as well as with cauliflowers, strawberries, raspberries, peaches, tomatoes, vines, and a variety of flowering plants, including roses, rhododendrons, and azaleas. All these plants being of a comparatively hardy character, the temperature in this house was maintained as nearly as possible at 60° Fahr.

The early effects observed were anything but satisfactory. While under the influence of the light suspended in the open air over the sunk houses, the beneficial effects due to the electric light observed during the previous winter repeated themselves, the plants in the house with the naked electric light soon manifested a withered appearance. Was this result the effect of the naked light, or was it the effect of the chemical products, nitrogenous compounds and carbonic acid, which are produced in the electric arc?

Proceeding on the first-named assumption, and with a view of softening the ray of the electric arc, small jets of steam were introduced into the house through tubes, drawing in atmospheric air with the steam and producing the effects of clouds interposing themselves in an irregular fashion between the light and the plants. This treatment was decidedly beneficial to the plants, although care had to be taken not to increase the amount of moisture thus introduced beyond certain limits. As regards the chemical products, carbonic acid and nitrogenous compounds, it was thought that these would prove rather beneficial than otherwise in furnishing the very ingredients upon which plant life depends, and further, that the constant supply of pure carbonic acid, resulting from the gradual combustion of the carbon electrodes, might render a diminution in the supply of fresh air possible, and thus lead to economy of fuel. The plants did not, however, take kindly to these innovations in their mode of life, and it was found necessary to put a lantern of clear glass round the light, for the double purpose of discharging the chemical products of the arc, and of interposing an effectual screen between the arc and the plants under its influence.

The effect of interposing a mere thin sheet of clear glass between the plants and the source of electric light was most striking. On placing such a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant, for instance a tomato plant, it was observed that in the course of a single night the line of demarkation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of 9 feet to 10 feet, was distinctly shriveled, whereas that portion under cover of the clear glass continued to show a healthy appearance, and this line of demarkation was distinctly visible on individual leaves. Not only the leaves but the young stems of the plants soon showed signs of destruction when exposed to the naked electric light, and these destructive influences were perceptible, though in a less marked degree, at a distance of 20 feet from the source of light.

A question here presents itself that can hardly fail to excite the interest of the physiological botanist. The clear glass does not apparently intercept any of the luminous rays, which cannot, therefore, be the cause of the destructive action. Professor Stokes has shown, however, in 1853, that the electric arc is particularly rich in highly refrangible invisible rays, and that these are largely absorbed in their passage through clear glass; it therefore appears reasonable to suppose that it is these highly refrangible rays beyond the visible spectrum that work destruction on vegetable cells, thus contrasting with the luminous rays of less refrangibility, which, on the contrary, stimulate their organic action.

Being desirous to follow up this inquiry a little further, I sowed a portion of the ground in the experimental conservatory with mustard and other quick-growing seeds, and divided the field into equal radial portions by means of a framework, excluding diffused light, but admitting light at equal distances from the electric arc. The first section was under the action of the naked light, the second was covered with a pane of clear glass, the third with yellow glass, the fourth with red, and the fifth with blue glass. The relative progress of the plants was noted from day to day, and the differences of effect upon the development of the plants were sufficiently striking to justify the following conclusion, viz., under the clear glass the largest amount of and the most vigorous growth was induced; the yellow glass came next in order, but the plants, though nearly equal in size, were greatly inferior in color and thickness of stem to those under the clear glass; the red glass gave rise to lanky growth and yellowish leaf; while the blue glass produces still more lanky growth and sickly leaf. The uncovered compartment showed a stunted growth, with a very dark and partly shriveled leaf. It should be observed that the electric light was kept on from 5 P.M. to 6 A.M. every night except Sundays during the experiment, which took place in January, 1881, but that diffused daylight was not excluded during the intervals; also that circulation of air through the dividing framework was provided for.

These results are confirmatory of those obtained by Dr. J. W. Draper* in his valuable researches on plants in the solar spectrum in 1843, which led him to the conclusion in opposition to the then prevailing opinion that the yellow ray and not the violet ray was most efficacious in promoting the decomposition of carbonic acid in the vegetable cell.

Having, in consequence of these preliminary inquiries, determined to surround the electric arc with a clear glass lantern, more satisfactory results were soon observable. Thus peas which had been sown at the end of October produced a harvest of ripe fruit on the 16th of February under the influence, with the exception of Sunday nights, of continuous light. Raspberry stalks put into the house on the 16th of December produced ripe fruit on the 1st of March, and strawberry plants put in about the same time produced ripe fruit of excellent flavor and color on the 14th of February. Vines which broke on the 26th of December, produced ripe grapes of stronger flavor than usual on the 10th of March. Wheat, barley, and oats shot up with extraordinary rapidity under the influence of continuous light, but did not arrive at maturity; their growth having been too rapid for their strength, caused them to fall to the ground after having attained the height of about 12 inches.

Seeds of wheat, barley, and oats, planted in the open air and grown under the influence of the external electric light, produced, however, more satisfactory results; having been sown in rows on the 6th of January, they germinated with difficulty, on account of frost and snow on the ground, but developed rapidly when milder weather set in, and showed ripe grain by the end of June, having been aided in their growth by the electric light until the beginning of May.

Doubts have been expressed by some botanists whether plants grown and brought to maturity under the influence of continuous light would produce fruit capable of reproduction; and in order to test this question, the peas gathered on the 16th of February from the plants which had been grown under almost continuous light action, were replanted on the 18th of February. They vegetated in a few days, showing every appearance of healthy growth.

Further evidence on the same question will be obtained by Dr. Gilbert, F.R.S., who has undertaken to experiment upon the wheat, barley, and oats grown as above stated, but still more evidence will probably be required before all doubt on the subject can be allayed.

I am aware that the great weight of the opinion of Mr. Darwin goes in favor of the view that many plants, if not all of them, require diurnal rest for their normal development, and it is with great diffidence and without wishing to generalize, that I feel bound to state, as the result of all my experiments, extending now over two winters, that although periodic darkness evidently favors growth in the sense of elongating the stalks of plants, the continuous stimulus of light appears favorable for healthy development at a greatly accelerated pace, through all the stages of the annual life of the plant, from the early leaf to the ripened fruit. The latter is superior in size, in aroma, and in color to that produced by alternating light, and the resulting seeds are not at any rate devoid of regerminating power.

Further experiments are necessary, I am aware, before it would be safe to generalize, nor does the question of diurnal rest in any way bear upon that of annual or winter rest, which probably most plants, that are not so-called annuals, do require.

The beneficial influence of the electric light has been very manifest upon a banana palm, which at two periods of its existence, viz., during its early growth and at the time of the fruit development, was placed (in February and March of 1880 and 1881) under the night action of one of the electric lights, set behind glass at a distance not exceeding two yards from the plant; the result was a bunch of fruit weighing 75 pounds, each banana being of unusual size, and pronounced by competent judges to be unsurpassed in flavor. Melons also remarkable for size and aromatic flavor have been produced under the influence of continuous light in the early spring of 1880 and 1881, and I am confident that still better results may be realized where the best conditions of temperature and of proximity to the electric light have been thoroughly investigated.

My object hitherto has rather been to ascertain the general conditions necessary to promote growth by the aid of electric light than to the production of quantitative results, but I am disposed to think that the time is not far distant when the electric light will be found a valuable adjunct to the means at the disposal of the horticulturist, in making him really independent of climate and season, and furnishing him with a power of producing new varieties.

Before electro-horticulture can be entertained as a practical process it would be necessary, however, to prove its cost, and my experiments of last winter have been in part directed toward that object. Where water power is available the electric light can be produced at an extremely moderate cost, comprising carbon electrodes, wear and tear of and interest upon apparatus and machinery employed, which experience elsewhere has already shown to amount to 6d. per hour for a light of 5,000 candles. The personal current attention requisite in that case consists simply in replacing the carbon electrodes every six or eight hours, which can be done without appreciable expense by the under-gardener in charge of the fires of the greenhouses.

In my case, no natural source of power was available, and a steam engine had to be resorted to. The engine of six nominal horse power, which I employ to work the two electric lights of 5,000 candle power each, consumes 56 pounds of coal per hour (the engine being of the ordinary high-pressure type), which, taken at 20s. a ton, would amount to 6d., or to 3d. per light of 5,000 candles. But against this expenditure has to be placed the saving of fuel effected in suppressing the stoves for heating the greenhouses, the amount of which I have not been able to ascertain accurately, but it may safely be taken at two-thirds of the cost of coal for the engine, thus reducing the cost of the fuel per light to 1d. per hour; the total cost per light of 5,000 candles will thus amount to 6d.+1d.=7d. per hour.

This calculation would hold good if the electric light and engine power were required during, say, twelve hours per diem, but inasmuch as the light is not required during the daytime, and the firing of the boiler has nevertheless to be kept up in order to supply heat to the greenhouses, it appears that during the daytime an amount of motive power is lost equal to that employed during the night.

In order to utilize this power I have devised means of working the dynamo-machine also during the daytime, and of transmitting the electric energy thus produced by means of wires to different points of the farm where such operations as chaff-cutting, swede-slicing, timber-sawing, and water-pumping have to be performed.

These objects are accomplished by means of small dynamo-machines placed at the points where power is required for these various purposes, and which are in metallic connection with the current generating dynamo-machine, near the engine. The connecting wires employed consist each of a naked strand of copper wire supported on wooden poles or on trees without the use of insulators, while the return circuit is effected through the park railing or wire fencing of the place, which is connected with both transmitting and working machines by means of short pieces of connecting wire. In order to insure the metallic continuity of the wire fencing, care has to be taken wherever there are gates, to solder a piece of wire buried below the gate to the wire fencing on either side.

As regards pumping the water, a three horse power steam engine was originally used, working two force pumps of 3½ inch diameter, making 36 double strokes per minute. The same pumps are still employed, being now worked by a dynamo-machine weighing 4 cwt. When the cisterns at the house, the gardens, and the farm require filling, the pumps are started by simply turning the commutator at the engine station, and in like manner the mechanical operations of the farm already referred to are accomplished by one and the same prime mover.

It would be difficult in this instance to state accurately the percentage of power actually received at the distant station, but in trying the same machines under similar circumstances of resistance with the aid of dynamometers as much as sixty per cent. has been realized.

In conclusion, I have pleasure to state that the working of the electric light and transmission of power for the various operations just named are entirely under the charge of my head gardener, Mr. Buchanan, assisted by the ordinary staff of under gardeners and field laborers, who probably never before heard of the power of electricity.

Electric transmission of power may eventually be applied also to thrashing, reaping, and plowing. These objects are at the present time accomplished, to a large extent, by means of portable steam engines, a class of engine which has attained a high degree of perfection, but the electric motor presents the great advantage of lightness, its weight per horse power being only 2 cwt., while the weight of a portable engine, with its boiler filled with water, may be taken at 15 cwt. per horse power. Moreover, the portable engine requires a continuous supply of water and fuel, and involves skilled labor in the field, while the electrical engine receives its food through the wire (or a light rail upon which it may be made to move about) from the central station, where power can be produced at a cheaper rate of expenditure for fuel and labor than in the field. The use of secondary batteries may also be resorted to with advantage to store electrical energy when it cannot be utilized.

In thus accomplishing the work of a farm from a central power station considerable saving of plant and labor may be effected, the engine power will be chiefly required for day work, and its night work for the purposes of electro horticulture will be a secondary utilization of the establishment involving little extra expense. At the same time the means are provided of lighting the hall and shrubberies in the most perfect manner, and of producing effects in landscape gardening that are strikingly beautiful.

* Paper read before Section A, British Association Meeting, York.

* See "Scientific Memoirs," by J. W. Draper, M.D. LL.D., Memoir X.

New Method of Assassination.—A merchant of Santanda, Central America, was lately murdered by a new and ingenious use of dynamite. The charge was placed in the large lock of his store door, with the exploder arranged to be set off by the door key. He was instantly killed on attempting to unlock the door.

THE STRUCTURE OF GREENHOUSES.

IT is now some ten years since some of the more enterprising of the market gardeners near Boston began to experiment in raising lettuce, radishes, parsley, cucumbers, etc., in greenhouses. At first the experiments were not altogether successful, the lettuce was much of it "burned" or blighted, the hothouse lettuce got a bad name in the market, which still sticks to it, though some of the greenhouse lettuce is quite as good as any that is grown in hot beds, and it can be grown at considerably less cost by skillful hands in the greenhouse. The difficulty with the greenhouse arises from the difficulty of maintaining an even temperature during the severe cold nights of winter, and in the bright, sunny days of spring. The hot bed has the advantage of being well covered at night with mats and shutters, and by day can be more freely aired, when fine weather requires it. Still, the labor of raising a crop in winter, in the greenhouse, is very much less than in the hot bed, and consequently the greenhouse has grown in favor with the lettuce growers, who, by dint of hard firing in cold weather, and close attention to the ventilators in sunny weather, have succeeded in growing some very good lettuce. The other crops are more easily grown, with the exception of cucumbers, which demand a constantly high temperature, never below 60°, and a heat of 100° does them no harm. Those who grow cucumbers in winter provide a house with double glass in order to keep out the cold air; but for lettuce single glass is better, but it should be double thick, and of good quality.

When greenhouses were first built for lettuce, it was the prevailing belief that "bottom heat" was required. The beds were raised on a bench of planks, under which passed the circulating pipes from a hot water boiler. This plan is a bad one; the bed thus raised needs excessive watering to keep the earth moist clear down among the roots, for the earth would become very dry against the planks, unless heavily watered. Again, the heating pipes were not where they were wanted. In severe weather, the cold glass directly over the lettuce would cause it to freeze when the pipes under the bed were quite hot. The custom now is, to carry the pipes around the wall of the greenhouse, just above the lettuce, and to build up the beds with walls of brick or concrete, from the ground; some of the heating pipes also are carried along the paths between the beds, so as to distribute the heat evenly. When it is required to provide bottom heat for cucumbers, etc., this is easily provided by placing a few inches of hot dung under the plants, when transplanted, which, in spring, will suffice to carry them along till warmer weather makes bottom heat unnecessary. The location of a greenhouse as regards exposure to the northwest wind, will have much to do with success in keeping up the required heat in cold weather. Wherever a natural shelter of hills or woods is not at hand, it will pay well to build a high fence to break the wind from the north and west.

The most successful lettuce-growers have houses with a rather flat roof pitching to the south or southeast, with about one foot rise to six feet horizontal measure; a steeper roof than this is more difficult to heat; is too dry in atmospheric humidity, and more expensive to build; a steep roof will answer better, however, for cucumbers alone than for lettuce; in fact, I have never seen very good lettuce grown under glass with a steep pitch. Where the greenhouse is intended for lettuce, in winter, the temperature required at night is about 40°, and this can be attained with four heating pipes for a house twenty-four feet in width. After March 20, this will answer for cucumbers with a night temperature of 60°. When, however, the cucumbers or other tropical plants are to be kept growing through the winter, double the above amount of pipes is needed, and the glass also should be double, in order to gain the additional heat. I know of no satisfactory reason, why it is that a low, flat roof favors the growth of lettuce, while it is almost impossible to grow it well under a high, steep roof. Perhaps the explanation is to be found in the greater atmospheric humidity under the flat roof, and also to the more even temperature under sunlight, the steep roof being more quickly heated by the sun and requiring more ventilation, and excessive dryness always attends airing.

The amount of glass used for lettuce growing is quite large. One of my neighbors has greenhouses covering about 16,000 feet devoted to this purpose, and the amount is constantly increasing. It is much pleasanter working under glass in severe winter weather, than exposed to the weather as one must be in planting and working hot beds; the work under glass, however, is not so healthful; one takes cold very easily, on going out from the moist heat of the greenhouse into the open air, on a cold day, and care is required to avoid rheumatism and severe colds. Still the quickness with which lettuce is grown in the greenhouse, and the ease with which it can be protected from lice by tobacco smoking, gives a decided advantage, and the labor is very much less than is required for the same amount of hot beds. The consumption of lettuce is very large, and constantly increasing, and it is very likely to increase very largely in the future, since it is a most wholesome salad; most of our winter lettuce, however, which is produced around Boston, goes to New York for a market; the New York gardeners say this is because our climate favors its growth, but I believe it is to be found in the greater skill and enterprise of the Boston gardeners.—*W. D. Philbrick, in N. E. Farmer.*

GATHERING AND STORING APPLES.

IN gathering apples from the trees to store away for winter use, provide yourself with a strong, light ladder, some two feet wide at the bottom and tapering to a point at top—the two ends to be beveled together and pinned—this style of ladder being more easy to handle and place among the top branches of a tree, than the ones commonly used, and not so much danger of knocking off the fruit. A half-bushel basket made of white oak splints, with single handle extending from side to side, and a strong hook fastened thereto to hang up by on the limbs, answers the purpose best. In picking, take hold of the apple and by a gentle twist of the hand it will separate readily from the tree and still retain its stem. It should be gently laid (not carelessly thrown) in the basket, the contents of which, when full, should be carefully emptied upon a table fixed for the purpose, the same to be covered with a blanket or quilt to prevent bruising. This table should be about six feet long and three feet wide, and have a strip about two inches wide nailed all around the edges to keep the apples from rolling off.

The assorting and packing may now commence, in doing which it is best to make three grades of the apples—the one of perfect fruit, another of rather inferior quality, and the third of such as are fit only for cider or to be fed to the stock. In placing the first two sorts in barrels, lay a single course on the bottom, stems downward, and so proceed until the barrel is full, except that the late course should be placed with stems upward, taking care to shake the barrel well, a time or two, during the process of filling. Too much care cannot be taken in the above respects, for upon the careful observance of them all success in the production of first-class fruit depends, and without which a man had better sell his fruit for what he can get rather than attempt to keep it for a better market or more satisfactory prices.

The barrels so filled may then be headed up and set away in some cool place until the approach of winter, when they should be placed in a cellar, the temperature of which is never so cold as to freeze.

If one wishes to put up a few barrels of choice apples for sale, their preservation is not only greatly enhanced by wrapping each apple in paper as a further security against bruising in case of transportation, but it gives them a more attractive appearance on being opened.—*Baltimore Sun.*

KEEPING VEGETABLES IN WINTER.

THE storage of the bountiful harvests of autumn, for use in winter, is attracting more and more attention every year, so that our winter market is now almost always well supplied with a variety of roots, such as onions, beets, carrots, turnips, etc., as well as plenty of fresh cabbages, celery, and spinach, and also squashes.

The requirements of these crops for keeping well are very different, and depend upon conditions of temperature and moisture which are easy enough to understand but by no means easy to control in our fickle and ever-changing climate. Thus, the cool, damp air of a cellar is a good place to keep roots and apples, provided they can be kept moist and cold enough to prevent wilting.

This is quite out of the question in the modern dwelling-house cellar, in which the hot-air or steam furnace keeps up a constant disturbance of the air, and produces a dryness and warmth ruinous to the preservation of roots. Even when a partition separates the furnace from the store-room, the careless neglect to shut a door or the cracks that often occur in a board partition are frequently the occasion of a dryness and heat in the store room utterly unsuited to the preservation of such products as roots or apples. There are other good reasons for not using the house cellar for storing vegetables; if neglected in spring and summer the remnant that remains at this season frequently becomes a nuisance and a cause of disease in the household. For these reasons it is better to make a cellar under some shed or carriage house, or the barn, for roots and apples.

The conditions required for keeping spinach are very similar, namely, a low temperature, near the freezing point, and very slight circulation of air. A cellar as ordinarily built, mostly under ground, is apt to be too warm, and for this reason a cellar whose walls rise slightly above the surface is better. The spinach is spread upon shelves, with spaces between the boards to allow free circulation of air; usually two or three shelves are built over each other, and the spinach is piled upon them about six inches deep; slight ventilation is needed to keep the spinach well, but not too much, for it is easily damaged by either freezing hard or by wilting; slight freezing does no harm, if it can be kept from thawing frequently. A cold frame covered with sashes and shutters will keep spinach pretty well for a month or two after cutting it, but is too subject to frequent freezing and thawing in changeable weather to answer well for a longer time.

Celery keeps well under similar conditions, except that it should never be allowed to freeze at all after blanching. It is usually stored by heeling it in, quite thickly, in the bottom of a pit, which is covered with boards, and the boards protected from frost by a heavy coat of leaves, spent tan, or eel grass. It will not keep well in a common cellar, unless buried up in sand or loam, the air of a cellar being so dry as to cause it to wilt.

Onions keep well in a cold, dry cellar, if not too early; they should be stored in a dry loft or on a barn floor until cold weather endangers their freezing, say about Thanksgiving time, when they may be barreled and put in the cellar. They will also keep well on the floor of a loft, if allowed to freeze slightly, and then covered with hay to prevent frequent and sudden thawing, which injures them; they will endure about as much frost as apples.

To keep other roots, such as beets, carrots, and turnips, from wilting, it is a good plan to put them up in barrels with heads, or to pile them in the cellar about four feet deep, and cover the pile with a little straw or coarse litter, to prevent evaporation. If the cellar is kept cold, they will not sprout and grow; but this is not always easy to do, as mild weather approaches in spring, at which season a good pit keeps the roots in better order than any cellar can do.

To keep squashes well very different conditions are essential. The squash is a tropical plant and will not well endure cold weather; even an approach to the freezing point below 40° injures them for keeping, and if the temperature can be kept uniformly above 50° from the time they are harvested, it will be all the better; free circulation of air is essential also, especially when they are first gathered, and for several weeks afterward. A cellar with a furnace in it, where the temperature is above 50°, will keep them well. But a cellar without a fire is too damp and cold, and they will not keep long in it.

One of the best places to be found in most houses for keeping squashes is a closet against the kitchen chimney. They need looking over every two weeks to pick out the specked ones; they keep pretty well till spring, if carefully watched; the hard-shelled squashes, like the Hubbard and Marblehead, keep very much better than the turban and marrow varieties, which are mostly used in autumn for pies, etc.

Tomatoes picked quite green, just before frost endangers their destruction, and spread out upon the benches of a greenhouse or under the glass of a hot bed, will ripen after several days' exposure to the warmth of the sun, and prove very acceptable after the frost has destroyed the vines.

String beans may be easily dried by spreading them on a roof or other convenient place, and furnish an excellent winter dish; they need only to be soaked and cooked as if freshly picked. This method is not so generally known and practiced as it should be. String beans are a delicate dish in midwinter and well worth the slight trouble of saving them. Lima beans, shelled and dried, make most excellent stewed beans in the winter season, so much better than ordinary pea beans that one would be quite surprised at the difference who had never tried it.

The method of preserving cabbages for winter will be described in another paper.—*W. D. Philbrick, N. E. Farmer.*

THE CULTIVATION OF MEDICINAL PLANTS IN LINCOLNSHIRE.

PEPPERMINT.—DILL.—CARAWAY.—ROSEMARY.—HENBANE.—BELLADONNA.—ACONITE, ETC.

By E. M. HOLMES, F.L.S., Curator of the Museum of the Pharmaceutical Society.

THE district in Lincolnshire in which medicinal plants are grown has for its center a small village called Market Deeping, about three and a half miles from St. James Deeping, the nearest station on the Great Northern line of railway, between Peterborough and Lincoln.

On leaving the station a flat expanse of well-cultivated land is seen to extend as far as the eye can reach. The soil appears to be chiefly a yellowish loam, varying much in depth in different fields, and resting on a gravelly subsoil, while here and there may be seen a black, peaty mould, which has evidently, at one time, formed fen land, but is now reclaimed; wheat, barley, oats, kohl-rabi, and mangel wurzel, appear to be the chief crops.

The principal grower of medicinal plants in Lincolnshire is Mr. W. Holland—about 200 acres, out of 1,000 which he farms, being the usual amount under cultivation.

The herbs most largely grown are the following: Peppermint, henbane, belladonna, dill, caraway, squirting-cucumber, and *Lactuca virosa*. Savin, rosemary, wormwood, thyme, and lemon thyme, are also occasionally cultivated in small quantity for the distillation of the essential oils, and aconite for the preparation of the green extract of the leaves.

Peppermint.—The variety grown is the black peppermint; hence the fields, when seen at a distance, present a purplish-brown hue. But when the herb is cut and laid on the ground, previous to carting away, the pale green color of the under-surface of the leaves, being exposed, contrasts strongly with the purple of the uncut portion. About 100 to 200 acres are usually under cultivation with pepperment.

The plant is propagated in the spring by suckers. As soon as the young shoots from the last year's crop have attained a height of four inches, they are pulled out and transplanted into new soil. These grow vigorously the first year, and throw out numerous stolons above the surface of the ground; hence, in the autumn, the first crop has always to be cut by hand with a sickle, to prevent injury to the stolons. After the crop has been removed, these are allowed to harden, or become woody, and then farmyard manure is scattered over the field and plowed in. In this way the stolons are divided into numerous portions and covered with soil. If the autumn proves wet, the stolons do not harden, but become sodden and rot, and a failure is the result; but if the weather be favorable, and the plants retain their vitality, the field is top-dressed in the spring with Peruvian guano.

In fresh ground the peppermint requires hand weeding two or three times, as the hoe cannot be used without injury to the roots and stolons of the plants.

Besides this, it is necessary if the peppermint be grown in a field where dill or other aromatic herbs have been cultivated, to remove such scattered plants as may have arisen from fallen seed before distilling the oil.

Being naturally a damp soil, the ground seems to suit peppermint well, and the rust on the leaves does not often make its appearance; but moist heavy weather in August is apt to cause the leaves to drop off and leave the stems almost bare.

It is found that if a rope be run over the plants, one man walking along one furrow, and another along the nearest one, so as to remove excessive moisture from the herbage, the rust may be, to a great extent, prevented from spreading.

The gathering of the herb for distillation commences about the beginning or middle of August, and lasts for six weeks, the stills being kept at work night and day. The time for gathering is judged by the opening of the flower spikes. In fine sunshiny weather the flowers take about a fortnight to become fully expanded, and then the fields are gay with butterflies and other insects. This year, however, the damp cold weather has hindered the flowering, and the yield of oil will probably not be so large as would otherwise have been the case.

The herb of the second and third year (for the same plants rarely yield a fourth crop on the same land) is cut with scythes, and then raked by women into loose heaps ready for carting. A group of boys then follow, and glean the stems which have escaped the sickle or scythe and add what they collect to the heaps. Owing to the operation of the School Board laws, it is often difficult to get sufficient labor in this sparsely-populated district, although every facility is afforded by Mr. Holland to his laborers to attend evening school, etc.

The herb is then carted to the manufactory, where there are five large copper stills at work, about seven or eight feet high, and five feet in diameter, and holding about five hundredweight of herb. A perforated false bottom, fitted with a large hook in the center, rests in it about two feet from the bottom of the still, and enough water is poured in to cover the false bottom about two feet. The still is then filled up with the herb, which is trodden in by men. The lid is then placed on and fastened down with two transverse bars. As the lid fits into a water joint, any excess of temperature and pressure is at once noticed by the water being jerked out of the water joint. Direct heat is applied instead of superheated steam, and consequently the oil is distilled at as low a temperature as possible, and is remarkably free from empyreumatic odor, the herb never coming in contact with the part of the still which is heated by the fire. The distillation is continued for about four and a half hours, and the lid is then removed, and a rope being attached to the hook on the false bottom, the whole of the herb is raised bodily out of the still by means of a windlass, and is taken away to the fields in the empty carts on their return journey. The used up herb is then left in heaps in the corner of the fields, and, as it still retains some odor, scents the air for a considerable distance, so that even before entering the village, and more than a mile from the works, a distinctly herbaceous odor may be perceived. Possibly the ozone developed in the atmosphere by the dissemination of the essential oil may conduce to health, for certain it is that the inhabitants appear to be very healthy, and the doctors have not too much work to do.

The heaps above mentioned, after being allowed to rot, are mixed with farmyard manure, then distributed over the peppermint fields, and plowed in as above described.

The yield of oil varies much according to the weather, being larger in proportion to the quantity of plant when the summer has been dry, and varying from one pound twelve ounces to five pounds per still.

On keeping, it much improves in mellowness, even if stored for so long a period as ten or fourteen years.

The distilled water is used over again for distilling fresh peppermint, except a certain quantity, which the laborers are allowed to take for home consumption.

The green color sometimes present in oil of peppermint is due to its being distilled with an unusually large quantity of water. On the other hand, if left in the still from Saturday evening to Monday morning, before distillation, the oil has a brown tint, probably due to slight oxidation.

The white variety of peppermint is not cultivated, as its growth is less vigorous, and its yield of oil small, and being therefore more expensive it is less in demand.

Dill.—About ten acres of this plant are usually under cultivation at Market Deeping. Of this quantity a portion is kept for selling as seed, and the remainder is distilled to obtain the essential oil.

The seed is sown in March, in furrows, in land which must be clean and in good condition, otherwise the weeds soon outgrow the dill, which is a slender plant, with little herbage, looking at first sight almost like starved fennel. If the weather be favorable the plants are full grown about the 10th of August. They are then two feet high, and the bright yellow of the blossom turns, toward the end of the month, to a rich golden brown as the fruit begins to ripen. If the weather be wet, and the ground sodden during the early summer, the plants are apt to damp off, but moisture, when the fruit begins to form, is beneficial rather than otherwise. As the plants do not all ripen simultaneously, and the mesocarps hang very lightly and easily fall off the umbels when ripe, the heads are collected for distillation when they are fully formed, but before they are quite mature. For this purpose the umbels are cut off close beneath the base, but when the seed is to be kept the plants are cut down as near the ground as possible, when the fruits begin to assume a brown color. After lying on the ground for a few days, to allow the seed to thoroughly ripen at the expense of the stem and leaves, the seeds are separated by sifting, the best being kept for seed and the rest distilled. During the period of ripening a great deal of seed is lost, and thus a field frequently reproduces another crop of dill without being sown.

The oil distilled from the green or immature fruit is said to have a more pleasant flavor and comes over more quickly than if distilled in the winter from dried seed, and hence the dill is taken immediately after being cut, to the stills. The yield of oil averages about three to four pounds per hundredweight.

The distillation commences usually about the 4th of September, and therefore before the peppermint distillation is finished.

All the crops of medicinal plants are grown in rotation, dill doing remarkably well after a crop of beans.

Caraway.—The amount of this plant under cultivation by Mr. Holland also averages about ten acres. The plant is a biennial, although, as with henbane, some plants persist in flowering the first year. It is sown in April in good soil, and the seed is collected in July. As it adheres more firmly to the umbels than in dill, it has to be thrashed to separate it. The amount of seed obtained varies from eight to twelve hundredweight per acre.

Like many other volatile seed oils, that of caraway does not improve by keeping.

Rosemary.—Only a small quantity of this plant is grown at Market Deeping, the climate being apparently too cold, rosemary requiring shelter from frost and from the north-east wind. It is propagated by cuttings, and the flowering tops are used for distillation because they yield more oil than the woody stems and of a better quality.

The distillation is continued from four to six hours, and the first, second, and third portions that come over are kept separately, that which first distills over being the finest in quality. The distillation commences about the third week in May, and the plant yields about eight ounces of oil per hundredweight.

Savin is grown only for the distillation of volatile oil, 112 pounds of tops yielding only six ounces of volatile oil.

Thyme and lemon thyme, spearmint and wormwood, are only grown occasionally for the distillation of volatile oil, the distillation commencing when the plants come into blossom.

Henbane.—The soil of Market Deeping seems well suited for henbane, the annual plant frequently springing up spontaneously on land which has been recently plowed, or in waste places where the surface has been disturbed.

The autumn leaves of the first year's growth of the biennial plant are here never stripped off for sale, since doing so is found to lessen the vigor of the growth of the next year.

As at Hitchin and elsewhere the crop is a very uncertain one, the seed sometimes refusing to come up, and sometimes the autumn plants, when they have made a luxuriant head of leaves, hold the rain, and the central growing point then rots during the winter, especially if the ground becomes sodden. At present the plants look healthy and strong, and a good crop may be expected next year if the weather be favorable. The growth of the seed, which is sown in March, seems in some degree to depend upon the depth at which it is buried and the firmness of the soil. When the earth is in a powdery state, and the seed not buried deeply, germination takes place more quickly and certainly. Some of the seeds usually develop into annual plants; these are now in flower. The seed of these can only be of use for herbalists, etc., by whom it is sold as a popular remedy for toothache.

The collection of henbane commences about the 6th of June and lasts till the middle of July, the flowering tops and leaves deprived of the midrib, as directed by the British Pharmacopœia, being alone used for drying. The drying is conducted in a perfect drying closet containing about one hundred and forty large sliding trays, the heat being furnished by pipes through which steam passes, a draught of cold air entering at the base and the heated air escaping by a flue at the top. In this way the herb is speedily dried without access of light. The presence of the stem leaves is said to give an equally active but better colored tincture than when the tops alone are used. In dry summers the lower stem leaves soon wither and the proportion of leaf to flower-buds therefore varies, the usual proportion being two-fifths of leaves and three fifths of flower-buds. The remaining portions of the plant, which consist of stem and midribs of leaves, are then submitted to hydraulic pressure, and the juice used in the preparation of extract, the yield being about four and a half pounds of extract per hundredweight.

The young plants, when too numerous, are often transplanted, and do not appear to suffer much from the process. Henbane does not seem to suffer so much from insect ravages as at Hitchin.

Belladonna.—Probably on account of the total absence in some places or of the small quantity of lime present in the soil, this plant does not seem to flourish so well as henbane. This year in some fields it had been a complete failure, the leaves being almost skeletonized by insects. Two forms of belladonna are noticeable in the fields, one having purple stems and somewhat decumbent habit of growth, and the other more erect and bushy, forming larger tufts and having a more vigorous growth. The plants vary from two to three feet in height and from one and a half to three feet across. The flowers do not appear to differ in the two varieties, being proterogynous in both, and the stamens and styles do not vary in length.

Belladonna is propagated by seed, which is taken out of the berries and washed and planted in the autumn. It comes up the following spring, and when of sufficient size is pricked out. The following year it is fit for cutting. The first crop of the leaves is collected in the beginning of July, and the second crop about the first week in September. As the plants grow larger each year their weight tends to split the root, and water getting into it, rots it so that the cultivation can rarely be continued beyond the third year in the same field. As much of the root as is in good condition when the land is plowed up is dried and sold.

Squirting Cucumber.—About two acres of land is annually devoted to this plant. As might be expected from its habit the seeds sow themselves, and being projected often from twelve to twenty feet, they may be frequently found scattered among potatoes or other crops near by. When these are discovered in time, they will bear being transplanted. The seeds are, however, often eaten by mice, which are very fond of them. Too much wet or cold in spring injures the crop.

It is collected from the beginning to the middle of September. A bushel of the fruits yields only from one quarter to one half an ounce of elaterium, whether sliced or bruised. The fruits are gathered while still green, but of full size; when they begin to turn of a pale or whitish tint they will not bear handling, the least touch sufficing to cause the fruit to eject its contents.

The juice is first strained from albuminous matters, through a sort of swan's-down material stretched on an oblong frame, such as is used for collecting precipitates. The juice is then allowed to settle and the sediment collected in fine linen and allowed to drain in shallow wooden trays perforated with holes about half an inch apart and with drainage furrows between the holes.

Lettuce.—Two species of this plant are cultivated for the preparation of extract, but not for lactucarium. One is the common garden lettuce and the other *Lactuca virosa*. The latter, like the henbane, although generally a biennial, often sends up some flowering stems and runs to seed the first year. The extracts from the two plants are prepared separately and sold as distinct articles, some buyers preferring the extract of the garden plant.

Dandelion Root.—Large quantities of dandelion root are dried by Mr. Holland, and extract and succus of excellent quality are also prepared. Singularly enough the extract, quite free from inulin, and which forms a clear solution, is not the one preferred by buyers, as it is rather more absorptive of moisture, although much superior for medicinal purposes. When gathered in spring the roots lose much more weight in drying than when collected in autumn.

Neither dandelion root nor conium are cultivated at Market Deeping, sufficient being collected in a wild state by the country people to supply all demands. Although there are a few others who grow medicinal plants in the county it does not, I believe, prove remunerative unless sufficient land is under cultivation to insure rotation of crops, and unless a manufactory can keep its hands going through the winter with the preparation of extracts and other products which do not require attention during the summer.

Aconite.—Two species of this plant are grown to meet the requirements of buyers: *A. napellus*, yielding an extract which is not perfectly smooth unless made so artificially, while *A. paniculatum* yields one which gives more satisfaction, on account of its being more easily worked and presenting a smoother appearance and less resinous character. The former plant flowers in May or June, and the latter from the middle of August to the middle of September, when *A. napellus* has scattered its seeds and its leaves are turning yellow.

Colchicum is not grown by Mr. Holland, and although the experiment has been tried and the corms grow to an enormous size, he is of opinion that they are less active than those of the uncultivated plant.

The careful farming and scrupulous cleanliness of the manufactory, and the care with which the various operations of distilling and making extracts are conducted, explain why Mr. Holland's products have obtained so high a reputation.

In conclusion, I cannot refrain from alluding here to the generous manner in which information that must have been the result of many years' careful observation was freely placed at my disposal, nor from mentioning that a visitor to the district cannot fail to observe the high esteem which Mr. Holland's kindliness and generosity have obtained for him among the poor as well as the rich of the district in which he lives.—*Pharmaceutical Journal.*

THE OPIUM HABIT.

THE New York *Medical Journal and Obstetrical Review* for October, 1881, contains an article by Dr. Edward C. Mann, of New York, on the nature and treatment of the opium habit. After giving an account of the extent to which the practice of opium eating is indulged in, and attempting an explanation of the ways in which the drug enslaves its victims, the author states that the opium or morphine habit is a curable disease, as other diseases are, and that he only desires to know that an opium sufferer honestly desires a cure to assure him that this result can be accomplished. If the opium habit is not eradicated, provided the physician has the moral support of the patient in desiring a cure, it is because the treatment is at fault in some respect.

Primarily, the patient must put himself under the necessary control. The nervous system of most of our modern Americans is too delicate, Dr. Mann thinks, to bear the shock of a total deprivation of the opium at once. Grave nervous disorders follow such a course. In his own plan of treatment he employs a reductionary course, keeping the patient's nervous system quiet with a combination of the bromides, gradually *increasing* the bromides as he *decreases* the morphia, until, on the tenth day after admission, the patient is taking *no* opium or morphine, and has avoided all suffering and nervous prostration. He generally combines the bromides of ammonium and sodium, and eliminates them from the system, after stopping the opium, by warm baths, sweet spirits of niter, and digitalis. The reflex action of the spinal cord, which has purposely been kept depressed by the bromides during the reductionary treatment, is now excited by strychnia, and the central nervous system is stimulated and invigorated by the daily use of the induced or faradaic current of electricity employed as general faradization. Nerve tonics are also employed, and an emaciated patient generally gains in a month's time from twenty-five to thirty-five pounds of flesh; his shattered constitution is built up, and in from four to six weeks he is generally well enough to be discharged, and to resume his position in society, entirely free from all craving for opium or morphia. Nothing but a thorough, systematic course of treatment can restore such patients to health, as there is no greater delusion than the belief in any specific to counteract the effect of opium or morphine in the human system and to eradicate the craving for the narcotic; and with such thorough, systematic treatment success is certain and invariable. An interesting case is given of an army officer who had been addicted to the use of opium for thirty-five years. He was fifty-three years of age. At the age of thirteen he went to China, and from there to India, where he discovered by experiment the fascination of the drug when eaten, and commenced the habit as a luxury. He was in the British army in India for twelve years, during which time he continued the habit, until, in the year 1856, he had reached the amount of 200 grains daily. Previous to this time he had repeatedly endeavored to break off from the habit, but each time succumbed to the intolerable suffering which he experienced. He applied at this time for treatment to a physician, who failed to eradicate the habit or even to quiet the craving for opium. He therefore continued to take this dose of 200 grains of opium daily, although he felt convinced that it was impairing his mental faculties very markedly. The will power had become so enfeebled that the morbid impulse or craving impelled him irresistibly, regardless of all consequences. He served through the Mexican war, and also through the late civil war. During the progress of the war, feeling that his memory was failing rapidly, and that his physical health was being undermined, he reduced his daily allowance to 128 grains of opium per diem. He was so fearful of being taken prisoner, and thus losing his opium, that he carried about his person a small pistol, determined, in the event of his capture, to commit suicide rather than undergo the torture which the sudden deprivation of his stimulus would cause. At the close of the war he commenced to take chloral as soon as he heard of its effect, hoping that he would be enabled to leave off opium. This, however, he did not do, but, continuing the opium habit and the chloral in addition, soon reached the amount of half an ounce, or 240 grains daily. Upon his admission to Sunnyside he was on the verge of insanity, emaciated, feeble, pale, and anæmic, with a feeble gait, no appreciation of his condition or surroundings, hallucinations of sight and hearing, and delusions of fear and persecutions. As he was much excited, several doses of a combination of sodium bromide and cannabis indica were administered, also chloral and hyoscyamus, and toward morning he became quiet. The next morning he was partially aware of his condition, but excited, with rapidly changing delusions and hallucinations; he was given beef tea and milk in small quantities at short intervals. A bitemporal current from four cells of the galvanic battery was applied for some minutes twice in the day, with the effect of calming the excitement, and the same medicines were continued internally. The following night he slept a few hours; on the third day of treatment there was marked improvement. The bowels, which had been obstinately constipated for a long time, were opened by enemata containing turpentine, and the intense restlessness and the delusions disappeared. From this time he was totally deprived of his chloral, and the morphine was gradually withdrawn; and after the withdrawal of the morphine the stimulating and tonic effects of electricity to the central nervous system, and the use of phosphorus, strychnia, and cod-liver oil as nerve tonics and nutrients, soon accomplished a complete cure.

THE TRANSFER OF SENSATION.

THE recent discoveries based on the conversion of electric currents into sound-vibrations have suggested the possibility of greater and wider results in the future. Is it not possible to convert light into electricity, and by this means to see objects and witness events not merely at great distances, but in spite of intervening objects? Is it not conceivable that the phenomena which depend on the absorption and reflection of light may be so translated as to become manifest to the sense of touch, thus robbing blindness of more than half its terrors?

Certain phenomena observed and recorded by Dr. J. G. Davey, of Bristol, and recorded in the "Journal of Psychological Medicine and Mental Pathology" (vii., Part 1), throw a new light upon this question, as well as upon certain allied subjects. It is now generally understood that the special senses, such as sight, are merely special developments of feeling. We find creatures utterly eyeless; others exist, again, which have very rudimentary and imperfect eyes, so that, though they are demonstrably conscious of the difference between light and darkness, they are unable to perceive objects. So far as we can judge, their outlook on the world is much the same as what we have if a piece of oiled paper or of ground glass were placed before our eyes. Such animals—*e. g.*, the Doridæ—have eyes placed beneath a skin which is not perfectly transparent, and which has no aperture. From the mere vague consciousness of light not clearly distinguishable from feeling, as met with in the lowest animals and possibly in plants, up to the distinct recognition of variously illuminated objects, as we meet with it in insects, birds, and mammals, we find a gradual chain of development. Sight is not a faculty *sui generis*, standing utterly apart, but has its root in that general sense of feeling which is distributed over the whole surface of the body. The same must be said of hearing, smell, and taste. The faculty which in its crudest state merely takes cognizance of solids becomes gradually refined, so as to be definitely affected by the undulations of the intermolecular ether.

From this point of view we can better understand what has been called the law of "organic compensation." If one organ is weakened or destroyed, its functions are to some extent undertaken by some other organ. That, *e. g.*, blind men become wonderfully acute in their senses of hearing and feeling has been known for thousands of years. Dr. Davey quotes, from the "Twenty-first Report of the Directors of the Hartford Asylum," the case of a girl, named Julia Brace, who had lost both sight and hearing, and whose sense of smell became wonderfully acute. "She has been frequently known to select her own clothes from a mass of dresses belonging to 140 persons. Her manner is to examine each article by feeling, but to decide upon it by the sense of smell; and in regard to her own things she is never mistaken. She has been frequently known to discriminate, merely by smelling them, the recently washed stockings of

the boys from those of the girls at the asylum." Having such facts before us, we need, be it parenthetically remarked, wonder little that an ant should distinguish strangers of the same species from its own fellow-citizens. Nor need we feel surprised that the ichneumon should become aware of the presence of a larva deeply buried in perfectly opaque matter.

But the case which Dr. Davey has to describe is of a much more remarkable character. It is not the mere increase of the acuteness of one special sense in compensation for the loss of others. The delicate sense of smell possessed by Julia Brace enabled her to distinguish objects by recognizing minute shades of odor which for ordinary human beings are non-existent. But it did not undertake the direct functions of the eye or the ear. It did not, *e. g.*, enable her to read. What, however, is to be said when we find a blind and deaf woman examining a picture or a photograph with the fingers of the right hand, and then being able to give a description—often full and detailed—of its coloring and the several objects thereon? What must we think that she is communicating with "by writing with the finger on her face, which is so sensitive that it receives and transmits to the brain the slightest movements of the finger, whether moved up or down, across, or in any direction?"

The first comment made in many quarters will be a lamentation about spiritualism, juggiery, *dominant ideas*, and the like. On this hand let us first hear Dr. Davey describe his own position: "I shall treat the subject in hand from a physiological standpoint. Of matters supernatural or forces outside nature I know nothing. If any one here expects me to discourse or speculate on the immaterial, the metaphysical, he will be disappointed: for this single and sufficient reason, I believe in nothing of the kind. As a materialist I hold that to degrade matter as is now done, to regard matter as else than the mainspring—the only direct and sufficient cause of each one and all of the vital phenomena—else than the ever-potent force at work in and through both the organic and inorganic worlds—and as such doomed, in virtue of natural law, to realize, ever and anon, that sublime adaptation of means to the end, at once sustaining, perfecting, and all-wise—so I say to degrade matter is to stem the tide of truth, of progress, and humanity. Matter and force stand now, as they ever have done and will continue to stand, in the near relation to each other of cause and effect, and so it is they cannot be separated from each other." Surely after such a confession of faith we need not expect Dr. Davey to err in the direction of the occult and mystical!

The woman upon whom the observations have been made is a Mrs. Croad, of Clifton. She became totally blind in 1870, deaf in 1871, and is moreover partially paralyzed.

In the experiments performed, in the presence of Drs. Davey, Andrews, and Elliott, every precaution seems to have been taken. The blindness of the patient was not taken for granted, but she was thoroughly blindfolded. Although "the eyelids of Mrs. Croad have been for many years persistently closed by a spasmodic action of the muscles," a pad of cotton-wool was placed over each orbit; "the face was then covered by a large and thickly-folded neckerchief; this was tied securely at the back of the head, and—even more than this—more cotton wool was pushed up toward the eyes on either side of the nose. Not content, however, the aid of two fingers of a bystander were called into requisition, and with these a continued pressure was kept up outside and over the neckerchief and wool, and above the closed eyes." Moreover the room was on two occasions very thoroughly darkened. Under these circumstances the experiments were conducted, and, as far as can be judged by any one not actually present, the results must be accepted as decisive proof that the fingers were doing duty for the eyes. On a picture card or a photograph being handed to her, she "places it on or about the chin or mouth, and perhaps draws it across the forehead, but the minute examination of the card is apparently the work of the fingers of the right hand. These several acts are, for the most part, followed by a quiet and intense thought, a well-marked concentration of mind on the picture, when, after a short time, she writes on a slate kept near her a description—sometimes a full and detailed one—of the card, its coloring, and the several objects thereon. Occasionally her rapid and precise perception— or, if you prefer the word, conception —of the picture, and of the many, though minute and trifling, objects going to form its entirety, is really startling."

We have already mentioned the manner in which Mrs. Croad's friends communicate with her, by writing, so to speak, with the finger on her forehead. This the author does not think very remarkable, all that is requisite being a heightened sensitiveness of the nerves of the face. But her daughter communicates with her in a different manner. Miss Croad does certainly move her fingers over and about the face of her mother, but—unlike visitors and friends—forms few, if any, letters or words. "As a rule it was simply requisite that she put herself in a close or personal contact with her mother, to convey to her what was wished."

Mrs. Croad is also said—indeed Dr. Davey gives an instance from his own experience—to have the power "of detecting, as it were, by sympathy or by a community of ideas and feeling, any letter written by a friend of hers, and put into her hands by a third party." We should be rather disposed to refer this power, if it really exists, to an intensification of the sense of smell, as in the case of Julia Brace.

There are other features of the case for which Dr. Davey does not personally vouch, but which are much more inexplicable. Thus: "It is said by those near and dear to her that such is Mrs. Croad's prevision that she has been known to have foretold my own visits to her: what I mean is, that on my approach to the house she occupies, but when still at a distance from it, and unseen by any one about her—in fact not within sight—she has said 'Dr. Davey is coming; he will be here directly.'" This is, indeed, very difficult to believe, and we shall take the liberty of referring it to that great group of occurrences, real or supposed, on which we suspend judgment. The author mentions, however, that his friend Dr. Maclean had, in the earlier part of his practice, a hysterical patient who displayed "the same lucidity." "But this is clairvoyance," will be the exclamation of many, "and, if clairvoyance, delusion!" What it is to be called seems, however, to us a very subordinate question. The first consideration is, Are the details above given, of the perception of pictures and photographs with the fingers, actual facts? We must avow that we see no reason to doubt it. The woman is pronounced blind, not merely on current report, but on substantial medical authority. The precautions taken, in case she still possessed any remnant of sight, seem fully sufficient, especially if we call to mind that on two occasions the room was darkened. The only loophole left for those who contend that Mrs. Croad and her friends are deceivers, and have succeeded in mystifying Dr. Davey and his professional friends, is the theory of collusion. Did any person present, for instance, and more especially the daughter, convey to Mrs. Croad hints as to the nature of the pictures and photographs by means of touches or pressure? It has been already stated that a peculiar "sympathy," or "community of ideas and sensations," existed between the mother and the daughter. This point has not escaped the attention of the author. He informs us that "Miss Croad stood or sat, as a very general rule, on the left of her mother and very close to her; in fact the head of Mrs. Croad reclined on the right shoulder of her daughter, to say nothing of the frequent, though temporary, contact of the fingers of Miss Croad with the cheek of her mother." Dr. Davey, therefore, very naturally asks, "In what relationship, if any, did such close and personal contact of these two persons stand to the strange perceptive power already explained with regard to the picture-cards and photographs? Was the said contact the cause or source in any degree of the lucidity or clairvoyance manifested over and over again by Mrs. Croad, and witnessed by so many?" It has been suggested that Miss Croad did, in some strange way, convey to her mother during the testing a knowledge of the cards, the objects represented on them, their colors, etc. Well, the suggestion was acted on: the same testing, on being again and again repeated, and in the absence of Miss Croad from the room occupied by her mother, proved altogether and conclusively in favor of Mrs. Croad. The same evidence of the same "transference of special sense" from the eyes to the fingers was always forthcoming.

Hence, therefore, except we are prepared to say boldly "*Tant pis pour les faits*," we must accept the phenomena as genuine, and may, if we please, pronounce them clairvoyance.

But we must now refer to the two cases where the experiments were performed, as it would appear successfully, in a darkened room. Here the eyes would evidently be at fault. Sight depends plainly on a perception of the rays of light partially absorbed by and partially reflected from the surfaces of bodies illuminated. But where there is no light, either absorbed or reflected, seeing, as we commonly understand it, can be performed neither by the eye nor by any other organ of the body acting vicariously in its stead. Two suppositions are, however, still open: Do objects which have been illuminated, and which in consequence of their varied coloration have been differently affected in different parts, retain for a longer or shorter time the power of acting upon a highly—we will say a morbid—sight organ? Is phosphorescence possibly a general property of matter, provided we had a sufficiently delicate test for its recognition?

Our second suggestion is, Do the phenomena above detailed prove the transference of the sense of sight from the eye to the finger-tips, or rather the development in them of a new sense not dependent on light in the ordinary sense of the term? The well-known experiment of Spallanzani on bats, which Dr. Davey quotes, as well as certain phenomena of insect life with which we have been much concerned, seem to favor this notion. The possibility of senses other than the five commonly recognized in man and the vertebrates generally cannot be rationally denied. Positive instances of their occurrence are still to seek.

Whether either of these suppositions will explain all the phenomena here noted is, however, doubtful.

The author says: "It should be stated that at my second interview with Mrs. Croad, and in the presence of Dr. Andrews and others, certain of my own personal and private convictions on a particular subject became as it would seem, in a strange and exceptional manner, known to Mrs. Croad. She asked me if I would allow her to tell me a secret in my own life-history, and would I be offended if she wrote it on her slate? I replied 'No.' That written on the slate was and is a fact, than which nothing could or can be more truthful and to the point. Dr. Andrews is prepared to verify this." Here all explanation of the present state of our knowledge is wanting. We fail to see how any known—it might almost be added any conceivable—sense could enable one person to perceive the past experience of another. Many readers will at once cut the knot by a simple denial. For our part we do not feel at liberty to escape from the difficulty in this manner. We are accustomed to accept the evidence of a gentleman and scientist unless we have already found him to be a defective observer and self-deceiver, or unless his statements are mutually contradictory or opposed not to imperfect and doubtful theories, but to established facts.

We read further: "It should be added, on the authority of Mr. Westlake, that Mrs. Croad asked his wife whether there was a room beyond (pointing where there was a passage). Being told 'Yes, two,' she said, 'What does the servant do down there at night when you are all in bed?' She was told that the servant had no business there, and the reply was, 'Well, she does go down there; I have known her do it more than once. She takes off her boots first.' It is added, 'We made inquiries, and found that when she thought we were all asleep the girl went into these rooms and helped herself'"—little thinking that her movements would be traced by a blind and deaf woman!

It is to be deeply regretted that such statements as we find in Dr. Davey's pamphlet, instead of being carefully verified and then rationally studied, as would be the case if some novel phenomenon in inorganic nature were concerned, are contemptuously denied by some, and purposely interwoven with charlatanism by others.—*Journal of Science.*

COPYING INK WITHOUT A PRESS.

A PAPER on this subject by Prof. Attfield, F.R.S., etc., was lately read at the annual Pharmaceutical Conference at York. The author stated that for the past thirteen years all letters, reports, etc., that he had written had been transcribed into an ordinary thin-paper copying-book with no more effort than was employed in using a piece of blotting-paper. It had only been necessary to place the page of writing, note size, letter size, or even foolscap, in the letter-book, and use a leaf of the letter-book just as one would use a leaf of blotting-paper. The superfluous ink that would go into blotting-paper went on to the leaf of the letter-book, and, showing through the thin paper as usual, gave, on the other side of the leaf, a perfect transcript of the letter. Any excess of ink on the page either of the letter or of the copying-paper was removed by placing a sheet of blotting-paper between them and running one's hand firmly over the whole in the ordinary manner.

This ready transcription was accomplished, as would be anticipated, by using ink which dried slowly. Indeed, obviously, the ink must dry sufficiently slowly for the characters at the top of a page of writing to remain wet when the last line was written, while it must dry sufficiently fast to preclude any chance of the copied page being smeared while subsequent pages were being covered. The drying must also be sufficiently rapid to prevent the characters "setting off," as printers term it, from one page on to another after folding.

The author then alluded to some difficulties attending the employment of the ink which had prevented its becoming an article of wholesale trade, but, he said, any chemist and druggist could make it and sell it, giving directions for use to customers. He himself had used it from year's end to year's end without any trouble whatever. It would be particularly useful to professional men and private persons.

The principle of the method of preparation consisted in dissolving a moderately powerful hygroscopic substance in any ordinary ink. After experimenting on all such substances known to him, he gave the preference to glycerin. Reduce, by evaporation, ten volumes of ink to six; then add four volumes of glycerin. Or manufacture some ink of nearly double strength and add to any quantity of it nearly an equal volume of glycerin.

THE PROGRESS OF BACTERIA INVESTIGATION.[1]

By G. MARPMANN.

No class of organisms has, during the last few years, incited so many experiments and has such results to register as the small limited division of the Protozoa to which Nägeli gave the name of "Schizomycetes." Whether these are fungi or algæ, belonging specially to the Oscillatoriæ, or are to be placed with the Monads at the commencement of the animal kingdom, is yet undecided. These beings form a kingdom by themselves, and have occupied, not botanists alone, but equally zoologists, chemists, physicists, medical men, and philosophers. Even the laity have become accustomed to take into account the bacteria, as they are shortly named, which are described to them as motes, and said to threaten health and life. Further, no other group of organisms have a similar sphere of distribution, since their existence is neither conditional upon water nor upon the oxygen of the atmosphere.

For this reason bacteria are found everywhere where organized matter presents to them the means of sustaining life; in water, in blood, and other animal juices and secretions, in plants, in the sediment of the deep sea, upon the glaciers of the highest mountains, and even in the freshly-laid hen's egg. They appear in abundance where organic matter putrefies slowly exposed to the air. Their spores and forms having the power of development occur in the air in every region and accumulate where the atmosphere is moist and but little disturbed.

Thus bacteria form a material for investigation easily obtainable, but their minuteness, transparency, and movements make them most difficult objects for examination. It is only in more recent years that, by the use of new methods of examination, it has been possible to study them more closely and also to figure the moving forms. Numberless observations are distributed throughout botanical and medical literature, and during the last ten years have taken a range known to no other class.

These facts impose upon journals dealing with departments of natural science the necessity of providing from time to time summaries of the progress of bacteria investigation. This is the object of the following lines, and I would remark beforehand that it is not intended to refer to all the observations of recent years, but rather to the principal of those which make us acquainted with the nature of bacteria and theories concerning them, and, when necessary to the explanation or establishment of a theory, to go back to the observations of earlier years.

1. *Recognition, Form, and Preservation of Bacteria.*—Most forms of bacteria are easy to recognize, and after one observation can scarcely again be confounded with other bodies. Only the smallest forms of micrococci or spheroid bacteria present some difficulties, and these may be mistaken, even by the practiced observer, for inorganic matter or coagulation. The chemical reaction of such colonies of micrococci was pointed out by Weigert:[2]

"The granular mass is insoluble in acetic acid, hydrochloric acid, caustic potash, glycerine, alcohol, chloroform, and oil of cloves. Hæmatoxylin alum colors it dark blue, as also does methyl violet with subsequent washing of the preparations in dilute acetic acid. The mass is colored red by carmine, hydrochloric acid, and glycerine, and brown by carmine and subsequent washing with dilute liquor ferri sesquichlorati. The formation is most beautifully seen when it is first treated with hæmatoxylin, then washed with dilute solution of potash, treated with concentrated acetic acid and examined in glycerine."

These reactions afford in doubtful cases certain evidence whether active bacteria or inorganic particles are before the observer.

So far as is known, all bacteria consist of single cells, and consequently their forms are not very manifold. Four fundamental forms are known: the spheroid, rod-shaped, thread-like, and spiral. These forms constitute at the same time the principal groups of the bacteria system. Of various experiments in systematic arrangement only the system of Cohn[3] will here be referred to. This includes in forty-five species the whole of the Schizomycetes, together with their next phycochrome-containing allies.

The question now arises, Are the different species true, and, consequently, confined to one definite form, or can one form pass into another? This question has a background rich in results, as will be seen subsequently. It has for the time separated investigators in two opposite directions, and has, consequently, not found a settlement. Hallier[4] saw the growth of bacteria into threads. Klebs[5] saw the conversion of micrococci into bacteria and these into contractile pigment granules. Billroth[6] assumes as the fundamental form the spheroid bacteria—*Coccobacteria septica*—which are said to multiply by elongation and division. Nägeli[7] takes the same standpoint, assuming the spheroid cell to be the fundamental form, and ascribing to it likewise the power of elongation and transverse division. On the whole, the

[1] From the *Pharmaceutical Journal*.—Translated from the "Archiv der Pharmacie" [3], vol. xv., p. 31.

[2] "Jahresbericht der Schlesisch Gesellsch. für Vaterland Cultur," 1875, p. 230.

[3] "Beiträge zur Biologie d. Pfl.," vol. ii., p. 3.

[4] "Zeitschrift f. Parasitenkunde," vol. ii., p. 2.

[5] "Vierteljahrsschrift f. gerichtl. Medicin, 1873, p. 269.

[6] "Untersuchungen über die Vegetationsformen der Cocco-bacteria septica." Berlin, 1874.

[7] "Uber die niederen Pilze," "Deutsche Med. Wochenschr.," 1876, 580.

morphological distinctions of the different forms appear to Nägeli to be "too small," and the functional distinctions as "not proven." For instance, according to him the lactic fermentation and putrefaction are caused by the same bacteria. On the other hand, he disputes the passing of bacteria into the higher fungoid forms.

The other section, who maintain the truly specific character of the different bacteria, have their principal supporter in Cohn, according to whose investigations of the "Haubercillen" [1] the specific character of this form is established. Ogston [2] brings direct evidence against the opinion of Billroth and Nägeli as to the transformation of the micrococci. He bred micrococci under a Lister's bandage in fresh hen's egg, and obtained a perfectly pure cultivation of them.

After forty days' cultivation of the injected egg at a blood heat, it was full of micrococci. It showed only the yolk broken up, the white being unaltered; while eggs that were heated with other organisms gave off a striking odor and showed an altered white with a blackened yolk. The final decision upon the specificity of a definite form is bound up with the difficulty of the pure cultivation of these smallest of organisms. Nägeli, in 1876, maintained a pure cultivation to be impossible. We have seen that Ogston has effected this with a micrococcus form, and therefore we may hope

Fig. 1.—Bacilli with terminal filaments. Magnified 500 times.

that it is not impossible to accomplish a pure cultivation of other forms. However, the direct observation of a change of form is equally difficult, probably more difficult than a pure cultivation. And it may be that to the united observations of Hallier and Klebs equally as little argumentative force belongs as to the theoretical conclusions of Billroth and Nägeli, but further arguments in this direction are not forthcoming.

On the other hand it is established that the relative dimensions alone are not sufficient to establish a species, since the propagation takes place both by transverse division and formation of spores, and therefore a single form would have a different dimension according to the age. Possibly particular actions belong to separate stages of the development, though this opinion loses generally in probability through the observations of Cohn upon the rapidity of the multiplication. In the domain of the chemistry of fermentation it has been demonstrated experimentally by Fitz [3] that two different glycerine fermentations are effected by two different forms of bacilli, one form being double the size of the other. According to the products of the fermentation Fitz distinguishes them as the ethyl and butyl bacillus.

The opinion that the forms are quite definite which produce the known fermentations and infective diseases, that these forms are not changed by grafting upon other substrata, and that they are confined within quite narrow conditions of life, has been strengthened by various experiments upon pathogenic Schizomycetes; for instance, Koch [4], upon *Bacillus anthracis*, the carbuncle bacillus; by Klein,[5] upon *Bacillus minimus*, in the typhoid of swine; by Klebs and Tommase [6] upon *Bacillus malariæ*, the excitant of malarial fever; by Obermeyer, Heydenreich, and others, upon the forms of Spirochætes in relapsing fever, and many other observations too numerous to mention.

A similar perplexity existed during sixty years in the distinguishing of the Diatomaceæ. Many species that were based upon differences in size had to be abandoned when investigators had learnt to recognize the developmental history of the families. So also the developmental history of the Schizomycetes will explain their systematology.

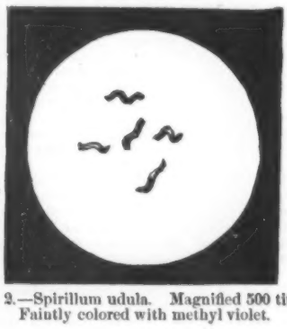


Fig. 2.—Spirillum udula. Magnified 500 times Faintly colored with methyl violet.

For the preservation of bacteria a very beautiful method has been made known by Koch [7]. It consists in drying the liquid containing the bacteria in a very thin layer upon the object glasses, so as to fix the bacteria in a plane, treating this layer with coloring material, and then again moistening it to restore the bacteria to their natural shape and make them distinctly perceptible, so that the preparation may be inclosed in a preservative liquid and finally be photographed. Object glasses with dried bacteria last for a long time, and can be transmitted very well. For the moistening of the layer Koch uses a solution of one part of acetate of potash in two of water. In this solution the bacteria take their original form without becoming loosened from the glass. For coloring he uses a mixture of a few drops of a concentrated spirituous solution of fuchsin or methyl violet with fifteen to thirty grains of water. The preparation so colored may be inclosed in concentrated solution of acetate of potash or in Canada balsam.

For photographing a preparation colored with aniline brown is best suited; this must be inclosed in glycerine. By this method bacteria investigation is essentially promoted. As above remarked, the small size, the movability, the absence of color or the power of refracting light, cause the greatest difficulties in the investigation of these beings. It is impossible in a swarm of moving bacteria to fix one specimen so as to measure or to figure it. By the method of Koch these difficulties are removed, and photography renders the more delicate conditions which are not perceptible in a direct observation or only with much trouble. In this way the glistening filaments which were first seen by Cohn, and afterward by Dollinger and Drysdal with great difficulty, are beautifully visible in the photographs. Mucus vesicles,

Fig. 3.—Spirochætes from the mucus of human teeth. Magnified 500 times.

spores, membrane, and protoplasm contents can also be well distinguished.

PHYSIOLOGY OF THE BACTERIA.

Bacteria are parasites; like all fungi they take oxygen from organic and inorganic oxygen compounds and give off hydrogen, which combines with the elements present to form hydrogen compounds. They are anaëroids, that is, they can develop and multiply in the absence of air. Some forms appear to require the exclusion of air for their regular development. The proof of this was furnished in 1876, by Hufner. He allowed pieces of flesh to stand in an exhausted vessel during two weeks together with water and some drops of putrid liquor. The gases evolved consisted of carbonic acid, hydrocarbons, and free hydrogen. The mass was putrescent, and showed an abundant development of bacteria. A simple method of detecting hydrogen in fermenting liquid was given by Selmi, which consists in mixing powdered sulphur with the fermenting substance, when the hydrogen set free combines with the sulphur to form sulphureted hydrogen. By this means the separation of hydrogen by moulds was recognized by Gigno Cugini. This simple fact furnishes an explanation of the chemical action of bacteria and the lower fungi. It may be affirmed that the action of bacteria generally is a reducing and exceptionally an oxidizing one. Whether exceptional forms can live—that is, can be propagated—upon air and water is doubtful; toward most bacteria air acts as a poison, as does light also toward many. These kinds take up their necessary oxygen from definite compounds of the nutritive substance. A chemical decomposition results, as final products of which CO_2, CH_4, and H in the case of non-nitrogenous substances, and NH_3 in that of nitrogenous subtances, have a tendency to appear. If the free hydrogen comes into contact with the oxygen of the atmosphere water and ozone are formed.

$$2H+2O_2=H_2O+O_3.$$

From this it may be concluded that bacteria excluded from atmospheric air exercise a reducing action, and in the presence of air probably an oxidizing one. Reducing actions are frequently referred to the life-process of bacteria.

Fig 4.

Thus the conversion of nitrate into nitrite was, as far back as 1868, ascribed by Schonbein, to the life-process of lower organisms.

Griessmayer,[1] Meusel,[2] and others found bacteria always to be the cause of the formation of nitrites in water.

The reduction of sulphuric acid by species of *Beggiatoa* has long been known; it takes place with separation of sulphur and sulphureted hydrogen. To this action many medicinal springs owe their contents in sulphureted hydrogen.

Oxidation processes go on, as already stated, probably only in the presence of air. Direct observation upon this point have been published by Pflüger,[4] who investigated the phosphorescence of putrefying organic matter, and found that phosphorescent fish, wood, etc., lose their phosphorescent powers in a vacuum and recover it upon access of air. Schizomycetes were recognized as the cause of the phosphorescence in phosphorescent fish, wood, and the slime of marshes. Bechamp [1] referred the oxidation of acetic acid to the action of bacteria.

According to the experiments of Schlösing and Munta,[2] the oxidation of ammonia to nitric acid in the soil depends upon the presence of bacteria in the earth. Bacteria would, therefore, also play an important part in the saltpeter plantations.

These processes are unimportant when compared with the changes which, known under the collective name of "fermentations," are due to the life-process of bacteria and the lower fungi. Ever since the commencement of scientific chemistry, from the time of Lavoisier, these fermentations have been an *enfant terrible*. Experiments to explain them have not been wanting, but investigators have been lacking the intellectual freedom to maintain the truth. Until the time of Darwin, all, or at any rate most, naturalists lay in the shackles of petty authorities, and these were not disposed to lose one atom of their intellectual sway.

Even at the present time, much in connection with this subject remains dark, so that we have often to content ourselves with empty words; nevertheless every year brings with it great empirical results which throw more and more light upon this darkness. But the scientific results of our time depend for the most part upon the unprejudiced judgment of empirical observations. That this was not the case

Fig. 5.—*Bacillus anthracis*, with formation of spores. Magnified 700 times.

thirty years since an example from Berzelius will show. Gay Lussac ascribed fermentation to the oxygen of the atmosphere, and subsequently to electricity. Fabroni sought the cause in the reaction of vegetable acids upon sugar. Berzelius now discovered fermentation to be a contact action; that is to say, he assumed in the ferment a catalytic power, which Liebig subsequently sought to explain by saying that the ferment itself was in a continued state of change, like sulphuric acid on the formation of ether. Putrefaction was said to depend upon the oxygen of the atmosphere, and preservation to the absence of this oxygen. For instance, peas boiled in closed flasks to get rid of the oxygen present in them were said to be thereby preserved.

C. de Latour [3] having, in 1836, recognized the yeast plant to be the cause of fermentation, this opinion was dealt with by Berzelius in the following words:[4] "In studying the formation of yeast under the microscope, C. de Latour has observed that it forms small globules, the number of which continually increases as though they were seed produced through a new kind of plant life, and Schwann goes so far as to declare that yeast is a species of living fungoid plant, because he has seen these globules aggregate to dendritic formed masses. This is, however, only a scientific poetic fiction!" So far the historical.

A table of the different processes of fermentation is found in vol. i. of Hoppe-Seyler's "Physiological Chemistry." He distinguishes two principal kinds of fermentation: those which are produced by ferments, complex organic compounds, in the absence of living organisms; and those which take place only in the presence of definite organized bodies. To the latter belong the decompositions of albuminoid bodies by bacteria. Whether these decompositions are directly occasioned by the life process of the bacteria, or whether the bacteria generate a ferment which induces fermentation, has not yet been decided with absolute certainty; nevertheless the formation of a ferment has not yet in any case been clearly proved. Upon the ground taken it is the same whether the bacteria are directly or indirectly the excitants of this process.

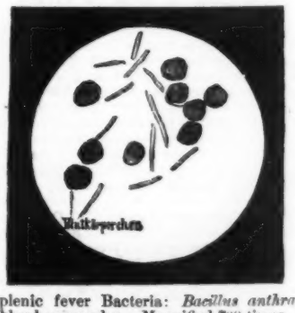


Fig. 6.—Splenic fever Bacteria: *Bacillus anthracis*, with blood corpuscles. Magnified 700 times.

The decompositions of albuminoid liquids, and the importance which these have for the animal organism, were well suited to excite the interest of physicians and surgeons in the highest degree, and we find that since about 1865 medical literature has been enriched by communications upon the subject in a yearly increasing number. We find since that time a transference of the bacteria investigation from the chemical and botanical literature into the medical.

As above remarked, bacteria are present in all the specific bacteria fermentations; these are, first, the putrid fermentations; in the second rank the lactic acid fermentation; and probably, in addition, some fatty acid and viscous fermentations of less importance.

It may possibly be affirmed that the putrid fermentation

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[1] "Beiträge zur Biologie der Pflanzen," vol. ii.

[2] "Upon Abscesses," "Archiv f. Klin. Chirurg., 1880, vol. xxv., p. 3.

[3] Article "Bacillus," Eulenburg, "Real-Encyclopadie der gesammten Heilkunde," 1880.

[4] Koch. "Wundinfectionskrankheiten," Leipzig (Vogel) 1879; and Cohn, "Beitrage z. Biologie d. Pflanzen, vol. ii., p. 2.

[5] "Proceedings of the Royal Society," 1878, No. 185.

[6] "Archiv f. Experimen. Pathol. und Pharm.," vol. x.

[7] Koch, "Verfahren zur Untersuchung, zum Conserviren und Photographiren der Bacterien;" Cohn, "Beitrage zur Biologie der Pflanzen," vol. ii., p. 3.

[1] Erdmann, "Journal," vol. cv.

[2] "Berichte d. deutsch. chem. Gesellschaft," 1878.

[3] "Berichte," 1875.

[4] "Archiv f. die gesammte Physiologie," 1875, vol. ix., p. 622.

[1] "Comptes Rendus," vol. lxxxiii., p. 158.

[2] "Journal de Pharmacie," 1877, vol. xxvi., p. 381.

[3] "Comptes Rendus," vol. iv., p. 905.

[4] Berzelius, "Chemie," vol. viii., p. 85.

is the final process of all decompositions of nitrogen compounds produced by bacteria. It has been demonstrated by Tyndall, Cohn, Koch, Pasteur, and many others that in the absence of bacteria no putrid fermentation takes place. Since this was demonstrated, experiments have been made to prepare a ferment from bacteria, but up to the present time ineffectually.

For this purpose P. Bert[1] used compressed oxygen, to separate organized from unorganized ferments, since he maintained that he had found the development of bacteria to be destroyed by it. But it was proved by Pasteur,[2] Joubert, and Chamberlain that the assumption of Bert was not correct. The last-mentioned brought together the results of his investigations in fifteen theses; the seventh thesis was: "Bacteria retain life and the power of development even in oxygen gas under the pressure of several atmospheres." Further, Bert attempted to kill the bacteria in a putrid liquid by means of alcohol, and finding putrid properties in a precipitate obtained through alcohol, concluded that it was a ferment. Through the experiments of Davaine,[3] on

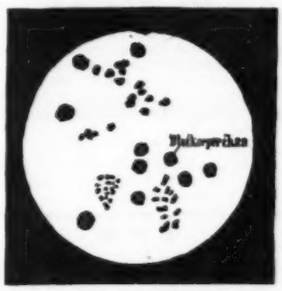

Fig. 7.—Sheep's blood, with various sizes of micrococci. Magnified 700 times.

the other hand, it was shown that probably the bacteria are killed, but not the spores, and that consequently alcohol checks the development of bacteria only so long as it is sufficiently concentrated. Feltz[4] prepared a spirituous extract from putrescent blood, which must have contained the ferment. This extract showed no putrescent action. From his experiments it appears that in putrescent blood no diastatic ferment, and no liquid virus would be contained; that the poisonous properties belong only to the organized bodies; that these bodies are destroyed at 150° C. and that therewith the poisonous character of the substance disappears. Further, he affirmed that probably compressed oxygen destroyed the elongated bacteria, but not the spores or globular bacteria.

Hiller,[5] one of the most zealous representatives of the ferment theory, repeatedly attempted to prove it by experiments which depended upon the separation of the bacteria from the substratum. He filtered putrid liquids through an earthenware cylinder, washed the residual bacteria with water, and found that these bacteria no longer possessed putrid properties. From this he concluded that bacteria are quite harmless bodies, which are present rather as accidents in the respective liquids. The corresponding action he attributed to a ferment which was present in the atmosphere as a solid body. Whether this ferment is soluble in water, and how the intensified potency of the ferment occurs with increased inoculation, is not evident. However, Hiller's experiments gave rise to criticism, because there was so much in them which was not clear, and his conclusions were refuted by the following experimental results.

Klebs, Pasteur, and Joubert found that splenic fever blood, which by filtration through an earthenware cylinder had been deprived of its bacteria, had lost its specific poisonous properties. On the other hand, these were found to be present in increased proportion in the residue.

Koch pointed out the changeableness of bacteria, especially of the *Bacillus anthracis*.

Heydenreich found that spirillæ in the blood of the living, died upon the increase of the body temperature by about 1° C. Downes and Blunt,[6] found that light stopped the development of the bacteria of putrefaction and fermenta-

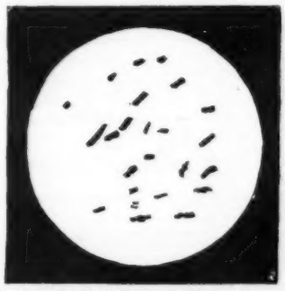

Fig. 8.—Various forms of Bacilli, with spores. Magnified 500 times.

tion, direct sunlight having the stronger action and diffused light the weaker. By these results Hiller's are more than refuted.

Hoppe-Seyler says in his "Physiological Chemistry:" "Putrescent substances do not cease to decompose albumen and hippuric acid when the lower organisms therein are killed by ether." On the assumption that the spores would resist dilute ether, I undertook, in the summer of 1879, the following series of experiments. A putrid solution of meat, which contained numerous moving bacteria, was mixed with an equal quantity of a fresh solution of meat, in order that during the period of the experiment there might be no want of nutriment. 50 c.c. of this liquid, previously neutralized with acetic acid, was placed in each of four vessels provided with gas tubes, and to the first portion 1 c.c. of ether, to the second 1 c.c. of chloroform, to the third 1 c.c. of benzin, and to the fourth 1 c.c. of carbon bisulphide was added. A microscopic examination showed that in every case the bacteria had subsided into the quiescent state. These vessels were then placed separately each under a bell glass, together with concentrated sulphuric acid.

In the specimens with ether and benzin some movable bacteria became perceptible, taking an average of three experiments in four days. The vessels, closed with a cork, gave upon warming a faint reaction of ammonia.

The two other specimens remained unchanged up to the seventh day. Some c.c. of colorless hæmatoxylin solution were then put in and the flasks corked. The chloroform specimen become somewhat reddened on the tenth day, but the carbon bisulphide not until the fifteenth day. These results confirmed my assumption.

According to all these experiments bacteria must be considered to be the direct cause of the putrid fermentation, and the decompositions can be explained through the three following processes: first, the direct decomposition of the nutritive material by the bacteria; second, the reaction of the liberated hydrogen, and third, the ozone possibly formed.

In direct connection with the experiments upon bacteria fermentation stand the disturbances of the metamorphoses of tissue produced by bacteria.

After the connection of bacteria was recognized, and the absolutely toxic property of certain substances containing bacteria was demonstrated, it was thought in this case, as in that of fermentation, that the substance would be found that produced these decompositions. The representative of the ferment theory sought here an alkaloid, the ideal septicine. As this theory is perfectly identical with the ferment theory, I can only refer to what has been previously stated, calling attention to Pasteur and Joubert's results, that splenic fever

Fig. 10.—Moving Micrococci from Drinking Water with traces of Albuminoid Substances. Magnified 800 times. Colored with Fuchsin.[1]

blood, which has been freed from bacteria, is innocuous when injected into the veins, and that on the contrary, the bacteria filtered out from it when introduced into the blood of healthy animals reproduce splenic fever.

As above remarked, it is the infective diseases which are directly caused by definite species of bacteria. Through the labors of Pollender, Brunell, Davaine, Klebs, Cohn, and

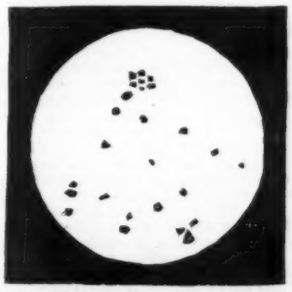

Fig. 11.—Aggregations of Micrococci from Drinking Water containing larger traces of Albuminoid Matter. Magnified 500 times.

Koch, the *Bacillus anthracis*, Koch, was recognized as the originator of splenic fever.

The signification of the bacilli first seen by Pollender and Brunell in the blood from splenic fever was for a long time doubted, until Davaine by inoculation furnished the proof that these are first multiplied locally, and that afterward their diffusion in the blood and the spleen bring on the serious phenomena of the disease. The same observers found moreover that the membrane of the ovum is impermeable to bacteria, in consequence of which the fœtus of a diseased animal is not infected; it follows as a further consequence that the bacillial one are the bearers of the virus. The developmental history of this form was exactly studied by Koch.[2]

The *Bacillus minimus*, Klein, was recognized to be the originator of pneumo-enteritis by Klein.[1] This disease is also carried by the introduction of infective substances into the stomach.

Klebs and Tommasi and Crudeli[2] found in the soil of the Pontine marshes a definite bacterium, the *Bacillus malariæ*, which when injected into animals produced the most severe forms of intermittent fever. Griffini found the same fungus in the soil of the Lombardi rice fields, and Marchiafava found it in several men who had died in Rome of virulent intermittent fever.

Obermeyer discovered, in 1870, in the blood of a patient suffering from recurrent fever, a spirochæte, which is probably identical with *Spirochæte plicatilis*, Ehrenb., occurring in water. Heydenreich[3] found that this fungus is very sensitive to variations of temperature. With a surrounding temperature of 15° to 22° C., it lives 14 days; at 37° to 38°, it lives only 15 to 21 hours; at 39·5° to 40°, only 4, or at most 9½ hours; and at 42·5° to 46°, it dies on an average in 2 hours. During the paroxysms these spirochæten occur constantly in the blood. According to Klebs they cannot be cultivated in pure water. In diphtheria a specific fungus, the *Microsporon diphtheriticum*, has been found.

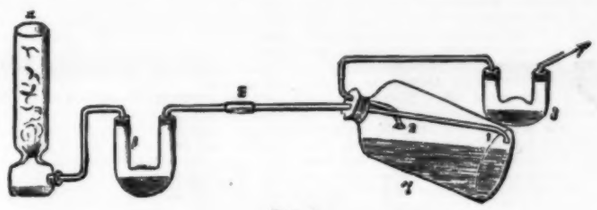

FIG. 9.

Of the numerous investigations of septicæmia those of Pasteur and Joubert[4] are prominent. These authors came to the result that septicæmia is caused by different putrefactive vibrios, and they believe that as many kinds of septicæmia occur as there are species of putrefactive vibrios.

In syphilis, glanders, and tuberculosis small moving corpuscles are found, which, however, on account of their minuteness have up till now presented great difficulties in their investigation. Nevertheless, the specific diseases have been produced by the introduction of these corpuscles into animals, while liquids that had been freed from the fungi were inactive. The connection of many other diseases with bacteria may be presumed, although up to the present time positive proof has not been brought forward. Of these may be mentioned cholera, plague, yellow fever, catarrh, inflammation of the internal organs, and articular rheumatism.

The question now arises, how do the bacteria get into the body? From the diffusion of these organisms, it is clear that we must consume a not inconsiderable number of them daily in our food and drink. However, they spend in the stomach and digestive canal only a miserable existence, since the acid liquid of the stomach is prejudicial to their living. Only when from other causes the acid of the stomach diminishes can the bacteria develop and then possibly induce disturbances in the metamorphoses. Still even here there are hinderances, since none of the pathological bacteria, with the exception of the *Microsporon diphtheriticum*, appear to be able, or only with difficulty, to penetrate the sound animal skin or mucous membrane. If, on the other hand, lesions in the skin are present, an easy way for the bacteria into the blood is thus opened. But probably these cases are referable mostly to the definite infection. As abiogenesis has not yet been proved, the only remaining possibility is the reception of the fungus with the inspired air.

Not long since it was believed that infection was effected through poisonous gases; the ozone in the atmosphere was suspected of producing certain inflammatory diseases, and to nitrous acid was ascribed the property of accelerating particular processes of fermentation, especially in a thundery atmosphere. Tyndall[5] showed that gases in these respects are very harmless. He placed vessels containing putrescent liquids in a germless compartment containing such gases together with clear sterilized solutions of meat. The con-

Fig. 12.—Micrococci from a Drinking Water containing H_2S. Magnified 500 times.

tents of the latter remained clear as long as no particles were carried over into the liquid.

After this experiment there remain only the bacteria as the bearers of the infection. If these are carried into the lungs with the inspired air their development is retarded by the oxygen, and this takes place in proportion to the vigor with which the breathing goes on. On the other hand the bacteria which are already in course of development, and consequently adhere especially to organic cell remains, develop more readily and can multiply in the blood. But the longer the introduction of these organisms into the blood continues, the more must the blood become adapted to the bacteria and the more the latter must multiply.

It is known that the forms of bacteria which have the greatest power of development require to be in dark, moist

[1] "Comptes Rendus," 1877, vol. lxxxiv., p. 1130.

[2] "Centralblatt fur Chirurgie," 1879, No. 3.

[3] "Comptes Rendus," 1877, vol. lxxxiv., p. 1222.

[4] *Ibid.*

[5] "Berliner klinische Wochenschrift." 1877.

[6] "Pharmaceutical Journal" [3], vol. viii., 312.

[1] Figs. 10, 11, and 12 are drawn from nature. The drinking water was always drawn from the spring to be examined into perfectly clear white flasks. These flasks were allowed to stand through a night, and in the morning a drop was removed from the bottom of the flask by means of a pipette and submitted to microscopic examination.

[2] Cohn, "Beitrage zur Biologie der Pflanzen," vol. ii., page 3.

[1] "Proceedings of the Royal Society," No 185 1878.

[2] "Archiv fûr exper. Path. u. Pharm.," vol. xi.

[3] "Klinische und mikroscopische Untersuchungen über den Parasiten des Rückfalltyphus und die morphologischen Veranderungen des Blutes in dieser Krankheit." Berlin, 1877.

[4] "Comptes Rendus," 1877, vol. lxxxv., p. 101.

[5] *Nature*, 1877, vol. xvi., p. 9.

places, containing an atmosphere poor in oxygen. By various examinations of cellar air, especially in fermentation cellars, which I had to carry out last winter in connection with a brewery, I found this fact confirmed.

In March of the present year I made some examinations of free air, in order to ascertain the possibility of a quantitative difference dependent upon the direction of the wind. The experiments were carried on in Schwerin i. M., in the loft of a two-storied house. Ten liters of air was drawn through about 3 c. c. of water free from bacteria. The water was placed in a small test tube, and the end of the inlet tube, which dipped beneath the water, was drawn out to a point. The small apparatus was fixed in the open air at a distance of about 5 feet from the house. The examination was made once daily for ten days. With a magnifying power of 500 I always found rod bacteria when an easterly wind was blowing; with a northerly wind fewer appeared to be present, as also with a calm, which, however, only lasted one day. In consequence of other work the experiments had to be discontinued, but it is desirable that similar experiments should be carried out for a longer time in different places, regard being paid especially to the direction and strength of the wind, temperature, moisture, etc.

Of similar importance to the occurrence of bacteria under different conditions is the subject of the circumstances under which the bacteria from putrescent matter get into the atmo-phere. As scarcely any experiments upon this subject were known to me, I examined, in the summer of 1879, various accumulations of putrescent matter as to the bacteria they gave off to a current of air. Three series of experiments were arranged; with putrescent liquid; with moist infected earth; and with pulverulent dry infected earth. In order to bring as much air as possible into contact with the material, they were placed in a three liter flask lying down. The apparatus consisted of an air filter of cotton-wool, α; a clear sterilized solution of flesh, β; the flask for the putrescent material, γ; another solution of flesh, δ, and the aspirator. The air swept through the point 1, over the material, and then passed through the funnel-formed opening of the tube, 2, into the flesh solution, δ. In every experiment air was drawn through for an hour and then the connection at ϵ was closed by a pinchcock.

In the experiments with putrescent liquid a turbidity was manifested in the flesh solution, δ, after two days, and with moist earth in the same time; but with pulverulent earth it had already become turbid in eight hours. The solution of flesh in β remained clear in every case. From these results it can be concluded that putrescent matter gives off its bacteria to a current of air with especial facility after drying; and that, on the contrary, liquid and moist putrescent matters give them off in proportion as they are disturbed by the air, the diffusion depending here on the strength of the current of air.

The greatest difficulty in the entire bacteria investigation is presented in the explanation of the pathogenic action. Theoretic attempts to solve this question have not been wanting, but the predisposition of individuals to account for different infections were all deficient in the scientific bases of experimental proof. Recent years have in this respect not brought any decisive experiments upon this subject. This finds an explanation in the fact that the preliminary questions are of a purely chemical nature, and can only be worked out by physiological chemists.

From the analogous fermentation phenomena conclusions may probably be drawn with some certainty as to the pathogenic processes. In the first place the general phenomena of infectious diseases exclude the acceptance of a specific poison. If a septic poison were produced by bacteria the diseases would have a course analogous to cases of poisoning. Schmiedeberg and Bergmann prepared such a "sepsin," which, however, proved to be more innocuous the purer it was. Panum, Nenski, Fitz, and Selmi obtained from infected matters different characteristic fermentation products, some of which could produce, for instance, stupor, weak action of the heart, and possibly increase of temperature, but the biological changes thus produced are only short links of the chain of phenomena of disease peculiar to the infection.

The mechanical attraction of bacteria to the sides of a vessel, and their considerable aggregation in the capillaries especially, evidently provoke special phenomena. Of great interest also are the gases evolved. The quantity of oxygen consumed in fevers amounts, according to the experiments of Mathieu and Maljeau,* to from 0·1 to 0·5 more than normal.

The heat developed by hydrogen as well as ozone authorizes the assumption that these gases play an important part in the increase of temperature. This possibly explains the *post mortem* increase of temperature, which in cases of fever frequently reaches 2° C. It has to be demonstrated experimentally how these gases behave in healthy animals in respect to rise of temperature.

It is incumbent upon chemists to study the decomposition products of the normal constituents of blood, etc., produced by bacteria, and physiologists to examine the influence of these products upon the metamorphoses of tissue. It would then be probably possible to explain the immunity of many classes of animals and separate individuals against different infective materials, as well as the diversity of diseases which are produced by different specific forms of temperature.

The practical results of the bacteria investigations are manifest in methods of preservation and disinfection, the antiseptic treatment of wounds by Lister's dressings and in the knowledge of epidemic diseases. Tyndall set forth the merits of Pasteur, the most active of bacteria investigators, in an address delivered at Glasgow on the 19th of October, 1876, in the following words: "If the labors of Pasteur be taken together, it can be said without exaggeration that the value of his work exceeds by far the war indemnity which France has paid to Germany. He restored to France the silk industry, rescued a numerous population from ruin, and set the looms of Italy again in activity." Our means of preservation and disinfection have given rise to entirely new processes in many technical industries, and it may be foreseen that still very much may be accomplished by a rational estimation of the results of bacteria investigation.

The results of bacteria science are of especial value to all who have to do with the examination of articles of food. Most of the questions which are brought to the "stationen" in Germany by private persons concern such articles of food as through external characters or special action following their use raise the probability of their being decayed or injurious to health. Chemical analysis of such substances, as a rule, leaves us in the lurch, and just as the microscope reveals to us many sophistications, so in these cases it alone can tell us whether the product in question is in a condition injurious to health.

" Centralbl. f. d. med. Wessenschaft." 1878, No. 15.

The examination of water for drinking purposes is complete only with the aid of the microscope, and the alleged injuriousness to health finds its confirmation in the detection of bacteria. There is probably at the present day no chemist who believes that the traces of nitrous acid, ammonia, etc., which he is able to detect in a drinking water can be in any way injurious to health.

During my superintendence of the Schwerin station for the examination of articles of food, etc., in the examination of drinking water I have found in some eighty cases that always where nitrous acid was detected, spheroid bacteria —micrococci—were present. In many cases according to the quantitative analysis the water would have been looked upon as good, but the presence of micrococci induced me to give my opinion that the water might under certain conditions act injuriously to health and that, therefore, its use should be avoided as much as possible. But where only a faint reaction resulted from tannin solution, the water was condemned as injurious to health, since I acted upon the presumption that water with traces of albuminoid matter is a nutritive solution for bacteria, and these develop to a greater extent in such a solution and can readily pass into the organism.

On one occasion, when gastric symptoms were referred to a drinking water containing micrococci, the symptoms disappeared upon the avoidance of the water. Further, in a sample of vanilla numerous moving bacteria were detected; food prepared with this flavoring had provoked headache and nausea.

On two occasions samples of beef, with the soup prepared from them, were received for examination. The soup had not been used on account of its milky appearance. Both in the flesh and in the soup bacilli and micrococci were found. The cause was due probably to diseased or decayed flesh. Also in braxey mutton, which had produced symptoms of poisoning after its use, numerous rod bacteria were found.

As remarked, in the waters only micrococci, not rod bacteria, were found, it would be interesting now to examine, whether in the water of alleged infective springs, which are suspected of spreading epidemics, rod bacteria are to be detected.

Pasteur and Joubert* found in their water examinations that the water of the Seine at Paris contained numerous germs of bacteria. A drop taken up the stream, but especially one down the stream, was always fertile, and developed several species of bacteria, the germs of some of which resisted heating in non-acid liquids to 100° C., and a dry heat of 130°, during several minutes. They found further that the distilled water of their laboratory always contained germs, though less than ordinary water. Distilled water prepared in vessels absolutely free from germs remained perfectly free from them.

Water from springs springing from the interior of the earth, which had not been contaminated by the dust of the atmosphere, the surface of the earth, or open flowing water, contained no trace of bacteria germs.

Finally, it has been found that these germs have so small a diameter that they pass through every filter.

We have now seen that the results of bacteria investigation are first of general importance; but that, secondly, they appeal in a special degree to the consideration of pharmacists and chemists, who have to do with the examination of articles of food.

* "Comptes Rendus," 1877, vol. lxxxiv., p. 208.

PRIZES WORTH STRIVING FOR.

THE Royal Academy of Medicine of Brussels announces a prize to be awarded in January, 1884, of eight thousand francs ($1,600), for the best explanation of the pathology and therapeutics of the diseases of the nervous centers, especially epilepsy, illustrated by clinical data and experiments. If the essayist is successful in making a decided advance in the therapeutics of such diseases; if, for instance, he discovers a successful treatment for epilepsy—he is to receive, in addition to the sum above stated, a second sum of twenty-five thousand francs ($5,000). This money has been placed in the hands of the Academy by a person who does not wish his name to appear.

In Italy, the Academy of Medicine of Turin offers a prize of twenty thousand lire ($4,000) for the best essay on "The Physiopathology of the Blood." This is the Riberi prize, and is open to the world, but the essay must be either in the Latin, French, or Italian tongue.—*Medical and Surgical Reporter.*

A CASE OF PROLONGED SOMNOLENCE.

That may serve as a companion piece to that of the sleeping Hungarian in Pennsylvania, is reported from one of the hospitals of Niederweisel, in Germany. The twelve-year old daughter of an innkeeper fell into a deep trance in March, 1880, and continued in that condition for the entire remainder of the year. No medicine was given her, and the small quantity of nutriment that was prescribed had to be administered by forcing her mouth open. She had normal sleep at night, but during the day lay wholly motionless, and apparently without sensation or consciousness. At first much emaciated, her appearance subsequently became fresh and healthy. About the beginning of the present year she suddenly recovered her power of speech, and was soon wholly restored in other respects. She is now entirely well. It is also said that during the whole period of her suspended animation she was fully cognizant of everything that took place about her.—*Medical Record.*

SWINE RAISING.

PURE air helps to make pure blood, which, in the course of nature, builds up healthful bodies. Out-of-door pigs would not show so well at the fairs, and would probably be passed over by judges and people who have been taught to admire only the fat and helpless things which get the prizes. Such pigs are well adapted to fill lard kegs, whereas the standard of perfection should be a pig which will make the most ham with the least waste of fat, the longest and deepest sides, with the most lean meat; it should have bone enough to allow it to stand up and help itself to food, and carry with it the evidence of health and natural development in all its parts. Pigs which run in a range or pasture have good appetites—the fresh air and exercise give them this—hence they will eat a great variety of food and much coarser than when confined in pens. Nothing need go to waste on the farm for lack of a market. They will consume all the refuse fruit, roots, pumpkins, and all kinds of vegetables, which will make them grow. By extending the root patch, and planting the fodder corn thinner, so that nubbins will form on it, and by putting in a sweet variety, the number of pigs may be increased in proportion. A few bushels of corn at the end of the season will finish off the pig. The pig pasture will be ready the next year for any crop, and ten times the advantage accrue to the farm than if the pigs are confined in close pens, for, as pigs are usually managed on the farm, but little manure is ever made from them.—*Col. F. D. Curtis, in American Agriculturist for October.*

AN ANCIENT DWARF.

AN interesting burial mound was opened near Monterey, Ky., recently. The mound was about four feet high, and contained a great many large stones. Apparently they had been carried a long way up a steep hill. At the bottom was found the remains of a strange being, just four feet high. His bones was very sound; his forehead was not an inch high, but was very broad. He was put away very carefully between flat rocks and covered with charcoal. On the mound there was a very large rotten stump, which looked as if it might have been a white oak three and a half feet in diameter. In the grave was found a spear, seven inches long, of red flint, also very curious flints of smaller size, and at his feet a singular speckled flint with a fine edge to it. The bones are not red like an Indian's, but of a dark, asby color. The teeth are perfect and seem to have been used a long time, which proves that he was old although only four feet high. There are other mounds similar to this one in that locality. They differ materially from the common Indian graves.

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